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[H]UMBOLDT RIVER BASIN
NEVADA

O.M.H.

REPORT NUMBER ONE
LITTLE HUMBOLDT SUB-BASIN
MARCH, 1962

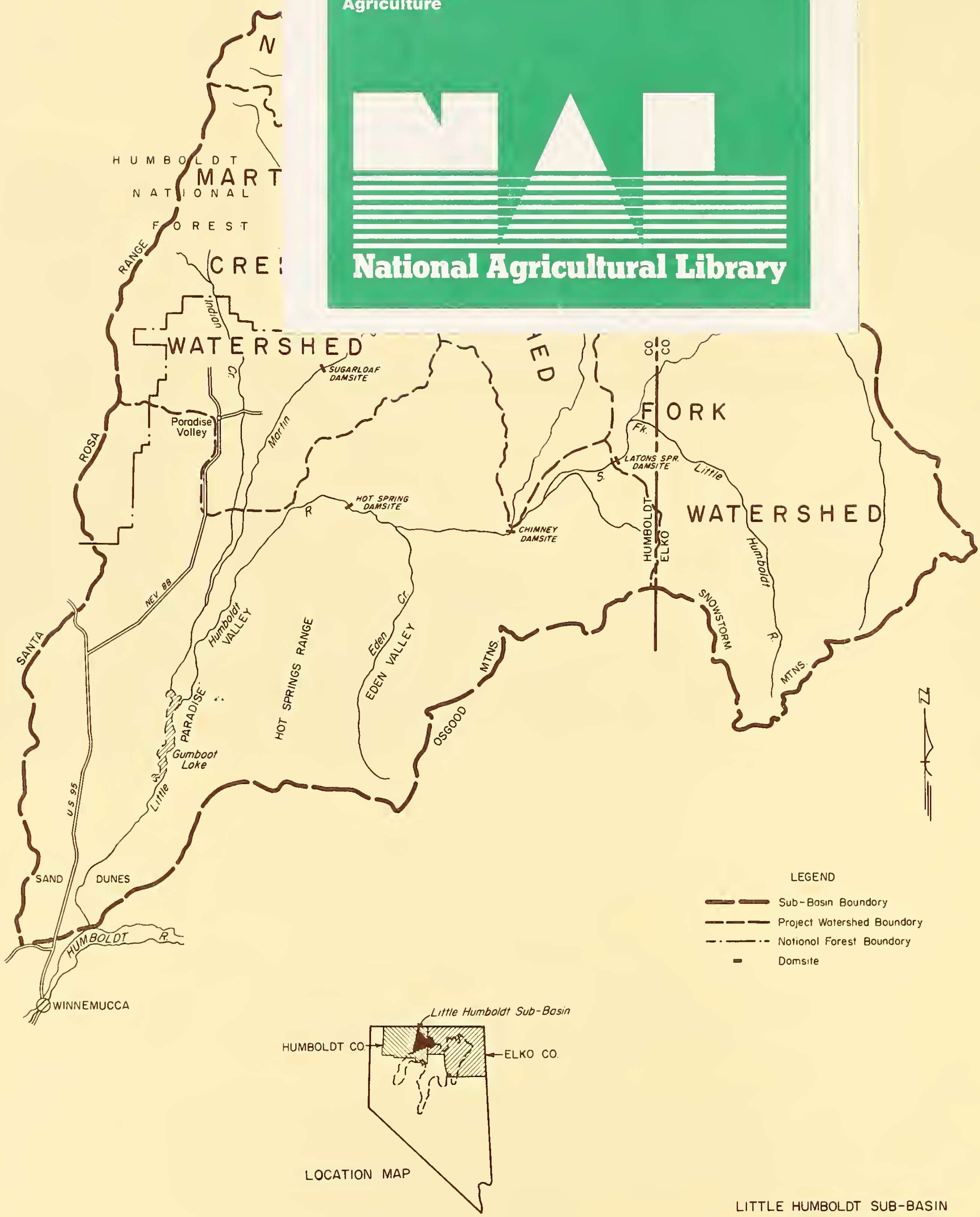
Based on a Cooperative Survey

by

THE NEVADA DEPARTMENT OF CONSERVATION AND NATURAL RESOURCES
and THE UNITED STATES DEPARTMENT OF AGRICULTURE

Prepared by

Economic Research Service - Forest Service - Soil Conservation Service



LITTLE HUMBOLDT SUB-BASIN
HUMBOLDT RIVER BASIN
HUMBOLDT & ELKO COUNTIES, NEVADA
MARCH, 1962

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SCALE IN MILES

7-L-16686

U. S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE USDA-SCS PORTLAND, OREG. 1962 M-3398

WATER AND RELATED LAND RESOURCES

REPORT NUMBER ONE

HUMBOLDT RIVER BASIN

NEVADA

LITTLE HUMBOLDT SUB-BASIN

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FOREWORD

This is a report for the people of Nevada, and particularly for the people of the Humboldt River Basin, concerning water and related land resources in the Little Humboldt Sub-Basin. It is the first of a series of reports which will result from a cooperative survey of the Humboldt River Basin by the Nevada State Department of Conservation and Natural Resources and the U. S. Department of Agriculture. It was prepared by the Soil Conservation Service, the Forest Service and the Economic Research Service of that Department.

The State of Nevada seeks constantly to assist local people and their organizations in the conservation, development and management of water resources. It has particular regard for the relationship of water to land and to human resources. This is exemplified by the creation of the Nevada State Department of Conservation and Natural Resources. A primary responsibility of that Department is to cooperate with Federal agencies and local groups and to coordinate State-Federal activities that help solve water and related land problems for the people of Nevada.

The responsibilities of the Nevada State Department of Conservation and Natural Resources, and the cooperative research work already underway in the Humboldt River, set the stage for Federal-State cooperation in developing information on opportunities for improving the use of the land and water resources of the Basin. Accordingly, cooperation was initiated with the U. S. Department of Agriculture under a Plan of Work dated June 3, 1960 with agencies of the Department and of the State of Nevada participating in the survey. It is important here to point out that responsibility for matters concerning State water rights and determination of water supply as it might affect State water rights was assumed by the State of Nevada.

This survey of the Humboldt River Basin is for the primary purpose of determining where improvements in the use of water and related land resources, some of which have significant social and economic aspects, might be made with the assistance of projects and programs of the U. S. Department of Agriculture. A major part of the survey is focused on situations where improvement might be brought about by means of Federal-State-local cooperative projects developed under the Watershed Protection and Flood Prevention Act (Public Law 566, 33rd. Congress, as amended). This cooperative survey is in keeping with long established tradition in the Department of Agriculture of cooperation with states and local entities in the conduct of its work. Further, such cooperation is a most important responsibility of the Nevada State Department of Conservation and Natural Resources.

The U. S. Department of Agriculture-State of Nevada Plan of Work in the Humboldt River Basin offers opportunities for participating in the survey by other Nevada State agencies and Federal agencies. The Bureau of Land Management, as an example, has cooperated with respect to the national land reserve. Thus, the survey is not limited but is rather as broad in scope and agency participation as is required to meet the agreed upon objectives.

The entire Humboldt River Basin is being studied by segments identified as sub-basins. The Little Humboldt Sub-Basin was studied first and a report has been completed. The report contains much information for study and use in understanding and solving some of the existing water and land resource problems. The report presents opportunities for Federal-State-local project type developments under the Watershed Protection and Flood Prevention Act, together with other opportunities for development and adjustment.

I wish to recognize the excellent work of the U. S. Department of Agriculture and the Nevada State Department of Conservation and Natural Resources in this cooperative effort. I consider that this report will serve the best interests of the people in the Humboldt River Basin and the State of Nevada.

Grant Sawyer

Governor of Nevada

HUMBOLDT RIVER BASIN SURVEY
LITTLE HUMBOLDT SUB-BASIN REPORT

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ORGANIZATION OF REPORT

The report on the Little Humboldt Sub-Basin is divided into three main sections. The first section is an overall report on the sub-basin; the remaining two sections consist of Appendix I and Appendix II, respectively.

Appendix I is attached to all the report copies, and contains pertinent textual matter concerning the sub-basin which is of value to the general reader.

Appendix II is produced in a relatively limited number of copies. Its small appeal to the general reader renders it unsuitable for inclusion with the report copies for general distribution. However, this type of material does have potential value as an information reservoir for technicians, administrators, and resource managers concerned with the Pine Valley Sub-Basin. Copies of this appendix are available upon request.

SUMMARY

The Little Humboldt Sub-Basin is comprised of a series of north-south trending valleys in eastern Humboldt County, north central Nevada. The triangular shaped sub-basin of approximately 1,729 square miles is a portion of a high semiarid plateau bounded by steep mountain ranges, with Paradise Valley being the principal broad flat valley. The Little Humboldt River rises in the Santa Rosa and Osgood Mountains and flows generally south to its former confluence with the Humboldt River at Winnemucca. The river is no longer a surface tributary to the Humboldt River due to the formation of a sand barrier across the lower end of Paradise Valley. The principal headwater tributaries are Martin, Cottonwood, and Indian Creeks from the northwest, and North and South Forks of the Little Humboldt River from the extreme north and east. Elevations vary from about 4,300 feet at the Sand Dunes to over 9,000 feet in the Santa Rosa Mountains. Precipitation ranges from an average annual of 8.85 inches along the valley floor to about 25 inches in the mountains and generally occurs during the winter months. The frost-free period averages 120 days along the floor of Paradise Valley. There are no existing or authorized Federal projects for flood control or irrigation water development in the sub-basin.

The sub-basin is sparsely populated. The 1960 population of Paradise Valley township was 281, an average population density of 0.16 persons per square mile. Virtually all of the people are engaged in livestock production or related work. Winnemucca, near the southern terminus of the sub-basin, had a 1960 population of 3,453.

The dominant agricultural activity in the Little Humboldt Sub-Basin is raising livestock. Approximately 35,000 acres of land along the major tributaries are irrigable and are devoted almost entirely to raising meadow hay, pasture, and alfalfa for fall and winter forage for livestock breeding herds. The national forest and national land reserve lands (public domain lands) comprising 130,560 and 712,960 acres, respectively, under grazing permits and licenses, provide spring and summer grazing for most of the breeding herds. (National land reserve lands are the former public domain, consisting of the public lands in continental United States administered by the Department of the Interior, Bureau of Land Management, which have never been set aside or reserved for any special purpose.) Water production and recreation use are other important functions of the Federal lands. Private and State-owned lands in the sub-basin which are used primarily as range for grazing livestock total 227,980 acres.

Surface irrigation water supplies are provided almost entirely by the perennial and ephemeral streams which enter the irrigated area of the valley floor at or near its northern end. Irrigation is principally by an extensive type of wild flooding. Except for diversion structures, channel improvements and limited land leveling on an individual ranch basis, there are few significant surface irrigation developments in the sub-basin. The area is subject to wide fluctuations in the total volume of the annual runoff of the streams. Frequently, channels and water control structures are inadequate to control the high seasonal flows which usually occur from March through June.

Water rights in the sub-basin were established by the E. P. Carville Decree in 1935. In general, the decree provides for a flow of one cubic foot per second per 100 acres of decreed land or at rates proportional to this as determined by variations in the supply of water that is available during the irrigation period. Rights are divided into three classes; class A applies to 30,361 acres and is for an irrigation period of 180 days; class B, 1,539 acres for 90 days; and class C, 10,087 acres for 45 days. Water is allocated to users on the basis of priority of right. The user with the earliest priority is served first, the second next and so forth until the entire flow of the streams is exhausted or all rights are satisfied.

During the irrigation period frequent adjustments are required to effect delivery of water in accordance with priority of right. Water supplies in the sub-basin are over-appropriated. The total quantity of water required to satisfy all existing rights, measured at the ranch headgate, amounts to about 121,000 acre-feet. The total annual median flow of the stream is estimated at 58,000 acre-feet.

Shallow ground water aquifers underlie the valley floor. The permeable sands and gravels extend from near the surface to a depth of about 300 feet. The ground water level is usually less than 10 feet below the land surface. Approximately 100 small capacity wells have been developed for domestic and stock use. During recent years 18 large capacity irrigation wells have been drilled to irrigate alfalfa and other cultivated crops, of which 12 wells are now in operation.

Approximately 41,100 acres of phreatophytes, primarily greasewood, rabbitbrush, silver buffaloberry, willow and saltgrass, are interspersed with the irrigated land along the valley floors. It is estimated that these phreatophytes consumptively use about 22,800 acre-feet of water annually.

Of the 1,071,500 acres of rangeland, 725,800 acres or 68 percent are considered to be at a low forage production level, 290,000 acres are classified as medium and only 55,700 acres are at a fairly high production level.

Wet-mantle floods along the Little Humboldt River result from heavy rain, rapid melting of snow, or a combination of these causes. Spring floods are usually due to heavy sustained runoff from melting snow occuring principally in April and May. Flash floods result from high intensity summer storms in localized areas. Practically the entire valley area along the river and the lower reaches of its tributaries is subject to flood overflows from the winter and spring floods which cause damage to farm buildings, land, crops, livestock, roads and bridges. Summer floods result in sheet, gully and streambank erosion in localized headwater areas. Damage from flooding and sediment deposition occurs to roads, bridges, irrigation facilities, and to lands and crops along the lower reaches of the tributaries affected.

The flow of the Little Humboldt River and its principal tributaries, both in amount and distribution, results in ill-timed and deficient water supplies for irrigation. The uncontrolled flooding of meadow and pasture lands during the wetter years results in reduced quality and quantity of forage production because of prolonged and excessive inundation. During the dryer years irrigated crop production is severely curtailed because of lack of water. Both of these situations impose difficult and costly adjustments in ranch operations.

Livestock and big game grazing have been associated with depletion of grass and browse stands, and the invasion of or increases in the densities of undesirable woody plants. This has resulted in decreased livestock forage production on the rangelands and on the pasture lands along the valley bottoms.

This investigation and survey of the Little Humboldt Sub-Basin considered primarily water conservation for irrigation, flood prevention, better water use through control of phreatophytes, increased efficiency of water use through the eradication of undesirable phreatophytes followed by the substitution of higher value forage plants, and the development of the ground water resource. Other considerations dealt with improvement of the hydrologic condition and the rehabilitation of the forage productive capacity of the rangelands through brush eradication, reseeding, fencing, water development, and livestock and big game control.

The survey revealed that agricultural improvements in the Little Humboldt Sub-Basin may be accomplished by the following general groups of measures:

1. The installation of water control structures including storage and detention reservoirs, channel improvement, floodways and distribution canals.
2. Development of the ground water resource through the installation of irrigation wells to supplement surface supplies during the late summer months and during drought years. Coordinated development of the surface and ground water would require sufficient safeguards to insure that overdrafts on the ground water supply during the drought years would be replaced from surface flows during the wet years.
3. Removal of low value phreatophytes and the establishment of higher value forage species by eradication of the woody species where the understory of native grasses is sufficient to revegetate the area, and by reseeding on suitable sites where native grasses are not present. Problems involved in reseeding of greasewood areas have not as yet been fully resolved.
4. Rehabilitation of depleted rangelands through brush eradication, land preparation and reseeding, fencing, stock-water development, and livestock and big game control to increase forage production, stabilize the soil and improve watershed conditions.

Regular Department of Agriculture and other Federal and State programs can provide assistance in improving, or can provide a means to accomplish many needed improvements in portions of the sub-basin. The regular programs of the Forest Service and the Bureau of Land Management provide for needed range, recreation, and watershed improvement on Federal lands they administer.

The problems in at least three watersheds in the sub-basin - Martin Creek, North Fork and South Fork - are such that they can best be handled on a project basis. Improvement measures can be designed to provide for watershed protection, supply late irrigation water, reduce frequent flooding, reduce sediment damage, and reduce erosion on the irrigated lands. For maximum protection to the irrigated lands in Paradise Valley all three projects should be developed and installed together. However, a project on Martin Creek watershed could be developed separately. The North Fork and South Fork watersheds should be developed as companion projects.

HUMBOLDT RIVER BASIN SURVEY
LITTLE HUMBOLDT SUB-BASIN REPORT

AUTHORITY AND ORGANIZATION

The need for continually improving the conservation and use of water and related land resources has long been recognized by Federal, State and local agencies, particularly in the western states. A recent pertinent development is authorization for the Secretary of Agriculture to cooperate with other Federal and with State and local agencies in making investigations and surveys of the watersheds of rivers and other waterways as a basis for the development of coordinated programs. This authority is provided by Section 6 of the Watershed Protection and Flood Prevention Act (Public law 566, 83rd Congress, as amended). In Nevada a survey under this authority has been undertaken by the U. S. Department of Agriculture and the Nevada State Department of Conservation and Natural Resources. The initial motivation for this survey was furnished about three years ago when the Director of this Nevada department invited the State Conservationist of Nevada for the Soil Conservation Service and the USDA River Basin Representative for the Pacific Southwest to explore with him the possibilities for river basin surveys in Nevada. This initial meeting and subsequent work resulted in the USDA - State of Nevada "Plan of Work" for the Humboldt River Basin dated June 3, 1960.

General direction for USDA in the conduct of the survey and preparation of the report was provided by the members of a USDA Field Advisory Committee composed of representatives of the Soil Conservation Service, Forest Service and Economic Research Service. The River Basin Representative served as advisor and consultant to the Committee.

General direction for the State of Nevada was provided by the Director of the State Department of Conservation and Natural Resources.

A Field Party, composed of representatives of the Soil Conservation Service, Forest Service and Economic Research Service conducted the field work and prepared this report with assistance from cooperating agencies.

Grateful acknowledgement is made to all individuals who gave their counsel and technical assistance in the preparation of this report.

GENERAL SUB-BASIN CHARACTERISTICS

The Little Humboldt Sub-Basin is comprised of a group of north-south trending valleys in eastern Humboldt County, north central Nevada. The sub-basin reaches northward from the Sand Dunes on the north side of the Humboldt River to the east-west extension of the Santa Rosa Range which is the north rim of the Humboldt watershed.

The entire drainage area of the Little Humboldt River above the Sand Dunes totals approximately 1,729 square miles. Paradise Valley is the principal valley in the sub-basin, being approximately 45 miles long and 13 miles wide. It is the northern division of a north-south series of connected depressions. Secondary drainages in the sub-basin, all essentially long and narrow, include the valleys of the Little Humboldt above the Hot Springs, and the upper reaches of Martin Creek. Martin Creek, north of Paradise Valley, contains about 179 square miles, and the Little Humboldt, east of Paradise Valley, 1,028 square miles. The small watersheds draining into the Little Humboldt River from the north and west total about 522 square miles in area.

The town of Paradise Valley, with a population of 281 (1960), near the north end

of the valley of that name, is the only town within the sub-basin.

Topography

The Sand Dunes form a low barrier across the south end of Paradise Valley. West of the valley floor, which has an elevation of approximately 4,300 feet, the Santa Rosa Range rises to elevations over 9,000 feet. The Owyhee Plateau and an east-west spur of the Santa Rosas form the north boundary of the sub-basin. To the east are located the Owyhee Plateau, elevation about 6,000 feet, and the Osgood Mountains, elevation over 8,000 feet. Within the sub-basin, another spur of the Santa Rosas diverges at Granite Peak and extends southeast, forming the northern boundary of Paradise Valley. The Hot Springs Range, over 6,000 feet, bounds this valley on the east.

Precipitation

The average annual precipitation in the town of Paradise Valley is 8.85 inches, based on approximately 40 years of U.S. Weather Bureau records. Most of this moisture falls as snow during the winter months. Occasional thunder storms occur during the summer, July and August being the months of least precipitation (see figure 1). Five snow survey stations of the Federal - State - Private Cooperative Snow Survey and Water Supply Forecasts for Nevada, which are part of the runoff forecast system in the Humboldt River Basin, are located within the sub-basin. A number of precipitation storage gages recently have been installed in this area, which in time will give a better indication of the precipitation pattern. Available information indicates that the average annual precipitation in the higher elevations of the Santa Rosas would be around 25 inches.

Growing Season

The frost free period (32°F) for Paradise Valley is approximately 120 days, based on records kept at stations adjacent to the valley. In the Santa Rosas, this period would be considerably shorter.

Soils

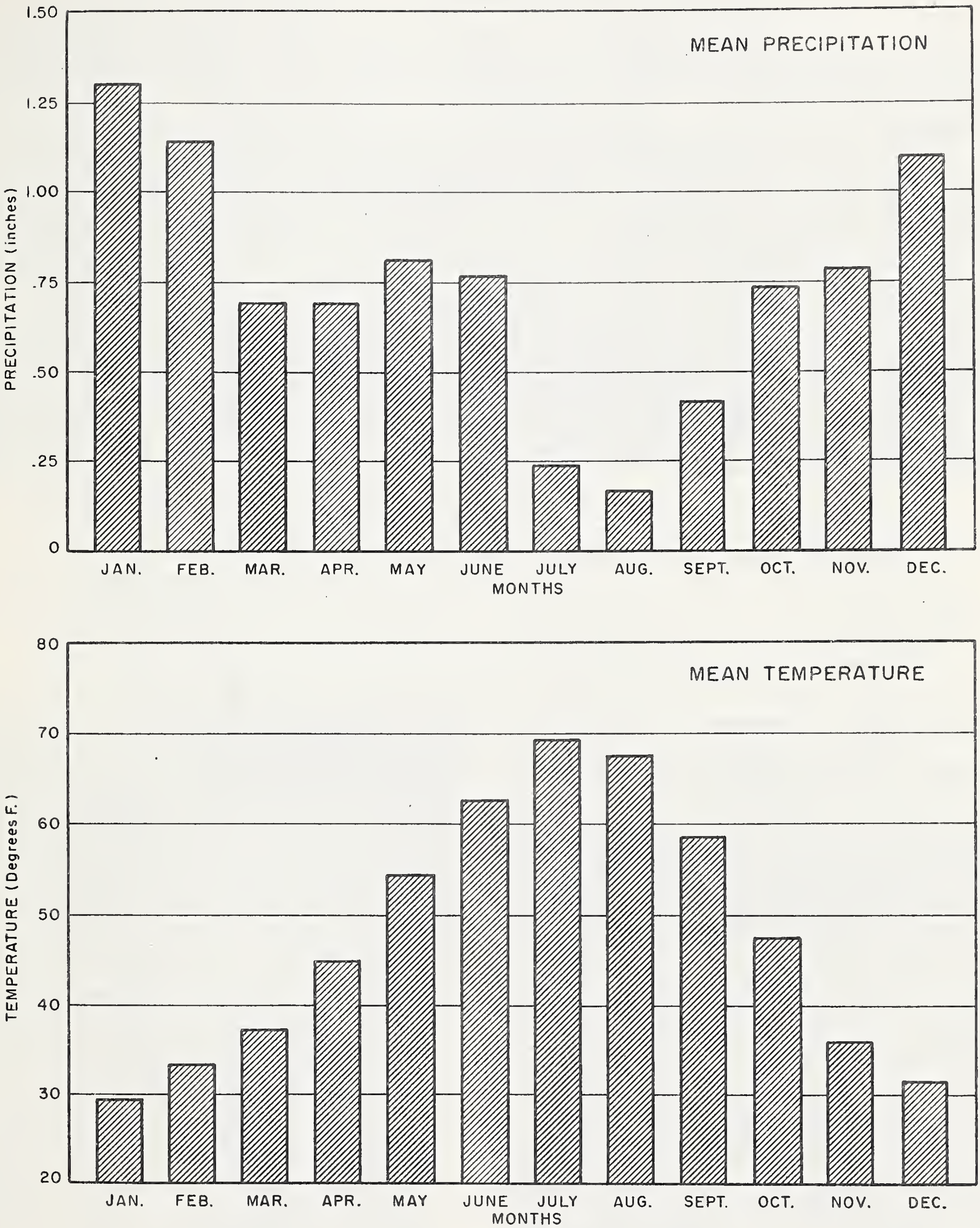
Soils in the Little Humboldt Sub-Basin represent members of ten Great Soil Groups that occupy physiographic positions on flood plains, alluvial fans, terraces, mountainous uplands and volcanic plains (see table 13 and Soils and Range Vegetal Site Map, Appendix I).

The parent material is varied, and consists dominantly of residuum and alluvium derived from igneous and metamorphic rocks that include granodiorite, rhyolite, dacite, basalt, gneiss, schists, quartzite, tuff, loess, and lake-laid silts and clays.

The soils above 5,000 feet elevation are mostly moderately deep to deep, stony and gravelly, medium-textured, and well drained. These soils have profile characteristics which are weak to strongly developed, and occur under a wide range of climatic conditions. There are some soils, however, which are shallow and coarse-textured, and are excessively drained. The land above 5,000 feet is the principal water yielding area of the sub-basin.

Below 5,000 feet elevation, there is considerable variance in the texture, drainage,

Figure 1. - Average Temperature and Precipitation Comparison, Paradise Valley, Nevada.



SOURCE: U.S. WEATHER BUREAU

and other characteristics of the soils. They are generally moderately deep to deep, imperfect to well drained, with texture varying from very fine sandy loams to silty clays, and range in salt and alkali content from none to high. Profile characteristics are slightly to strongly developed, and the soils occur under a rather narrow range of climatic conditions.

General Cover Conditions

Plant cover ranges from nothing on the shifting sand dunes in the lower sub-basin (see photograph 1) to groves of aspen and scattered conifers in the higher elevations of the Santa Rosa Mountains. The majority of the high country above 6,000 feet has a sagebrush-bunchgrass cover (Idaho fescue, bluebunch wheatgrass) interspersed with scattered coniferous and aspen timber, with a fairly high to low range forage yield (see photographs 2 and 3). The lower areas are predominantly sagebrush and greasewood. While the sagebrush is quite tall and thick in some of these lower areas, there is little perennial grass present as an understory. The range forage production is medium to low, with small areas having a fairly high forage yield.

Water Yield

Surface water supplies are provided almost entirely by the perennial and ephemeral streams which enter the irrigated area at the northern end of Paradise Valley.

The median stream flow is estimated to be about 58,000 acre-feet, based on annual water balance studies prepared by the Field Party, and on 39 years of record for Martin Creek (1922-1960). The extremes vary from 20,400 acre-feet in 1931 to 206,940 acre-feet in 1952 (see table 16, Appendix I).

Stream flow from the Little Humboldt Sub-Basin generally does not contribute to the surface water supplies of the Humboldt River. Only in years of exceptionally heavy runoff does water escape across the sand dune barrier into the main river valley.

The water supply for the Little Humboldt Sub-Basin is derived from the Santa Rosa Range and the Snowstorm Mountains in the Osgood Range, with few exceptions. The principal drainages that yield water used for irrigation are: (1) Martin Creek; (2) North Fork and South Fork of the Little Humboldt River; (3) Cottonwood Creek; and (4) Indian Creek.

The surface flow of the Little Humboldt Sub-Basin which may be expected with 80 percent and 50 percent frequencies, equal or exceeded, is shown below. The values shown are for drainages above all diversions.

Watershed	Surface flow (ac-ft) Frequency 80%	50%	Percent of total flow
Martin Creek (gaged)	12,500	19,500	32
Cottonwood Creek (calculated)	4,200	6,800	11
North Fork (calculated)	8,400	10,500	20
South Fork (calculated)	5,000	6,200	12
Milligan Creek and Eden Valley (calculated)	3,840	4,800	9
Other drainages (calculated)	6,300	10,200	16
Total	40,200	58,000	100

Photograph 1. - The Sand Dunes at the south end of the Little Humboldt Sub-Basin, looking eastward from Highway U.S. 95 - Nevada 8B. Snow-capped Osgood Mountains in background. 6-566-6 FIELD PARTY PHOTO

Photograph 2. - Range with a low to medium forage yield, near Goosey Lake Flat, North Fork Little Humboldt River, Humboldt National Forest.

Photograph 3. - Range with fairly high forage yield, Martin Basin, Humboldt National Forest.

FOREST SERVICE PHOTO

FOREST SERVICE PHOTO

With the exception of Martin Creek, which has 39 years of continuous stream flow records, the above flow values were calculated by the Annual Water Balance procedure (see Appendix I). Available stream flow records and intermittent stream flow readings were also used or considered. No runoff was computed for the western slope of the Hot Springs Range. Observations indicated that these mountains may contribute in a small way to the ground water supply of Paradise Valley, but that surface flow was infrequent and occurred only during periods of high precipitation.

A detailed water inventory was made by the Field Party in the main drainage of this sub-basin, as a basis for determining the possibility of water salvage for irrigation purposes. This study revealed that for a runoff which could be expected in an 80 percent frequency year from Martin Creek, which would amount to approximately 12,500 acre-feet, about 10 percent of the moisture which fell on the drainage showed up as runoff at the gaging station in the mouth of the canyon. The remainder, or 90 percent, was either evaporated, was used to sustain plant life on the watershed, or became ground water. This percentage would change with different amounts of precipitation, and to some extent with a change in the monthly precipitation pattern.

Ground water supplies also are available. The U.S. Geological Survey reports that shallow ground water acquifers underlie the valley floor (Ground Water in Paradise Valley, Humboldt County, Nevada, State of Nevada, Office of State Engineer, Water Resources Bul. 10, 1949). The permeable sands and gravels extend from near the surface to a depth of about 300 feet. Ground water in the shallow valley fill is usually less than 10 feet below the land surface along the floor of the valley. The gradient of the water table ranges from about 60 feet per mile at the extreme north end of the valley to about three feet per mile at the south end.

Ground water levels are reported to fluctuate about nine feet in the north end of the valley, five feet in the central portion, and two feet in the southern portion. The hydrographs for 1946 and 1947 indicate that the ground water level usually reaches its highest point during May, and gradually decreases until about October. This indicates the probability that from May to October a portion of the ground water along the entire valley floor is depleted by vegetal growth. The hydrographs also indicate the direct relation of ground water to surface water.

HISTORICAL INFORMATION

Settlement and Population

In 1863 farmers and ranchers began settling along the Little Humboldt River and its tributaries in Paradise Valley. The town of Paradise City, now known as Paradise Valley, was established in 1866. The growing of wheat, oats, hay, potatoes, and fruit, as well as cattle and sheep raising, were from the very beginning the important means of livelihood. By 1881 between 15,000 and 20,000 acres were devoted to the production of wheat and barley. Vegetables, poultry, eggs, and the raising of hogs, cattle, sheep, and horses gained in importance. The valley became the production center for food and feed supplies for the adjacent mining districts in Nevada and Idaho. With the decline of mining activity, beginning about 1918, agriculture gradually shifted from this more diversified farming to the raising of sheep and cattle. Within the last decade, sheep have been entirely replaced with cattle on Paradise Valley ranches.

The Little Humboldt Sub-Basin is sparsely populated. The 1960 population of Paradise Valley township was 281, an average population density of 0.16 persons per square mile. Most of the people in the sub-basin live in the town of Paradise Valley or within a 20-mile radius of the town. Virtually all are engaged in ranching or work related to ranching. Winnemucca, which is near the southern terminus of the Little Humboldt Sub-Basin, had a 1960 population of 3,453. It is the supply center for ranches in the sub-basin.

Floods

This sub-basin has been subjected to flooding and periods of high water at periodic intervals since 1862, the earliest flood year of record along the Humboldt and its tributaries, including the Little Humboldt River.

For further information on the history of floods and periods of high water in the Little Humboldt Sub-Basin see Appendix I.

Fires

Organized fire protection on the Paradise Valley Ranger District of the Humboldt National Forest was initiated in 1911. There have been no fires 100 acres in size or over since 1935, the earliest date for fire records on the Humboldt Basin portion of the District. However, an "E" size fire (over 300 acres) is reported in some Forest Service records to have burned over national forest lands in lower Indian Creek in 1936, although there is no official record of this fire.

On the national land reserve lands (formerly public domain) within the sub-basin administered by the Bureau of Land Management, 14 Class "E" fires have burned 26,456 acres of range and watershed lands since 1940, the earliest date of available fire records.

PREVIOUS STUDIES

Corps of Engineers

A preliminary reconnaissance report by the Corps of Engineers on its study of the Little Humboldt River and Martin Creek Watersheds listed four possible plans. The plans investigated were: (1) a 185 foot concrete arch dam on Martin Creek at the Sugar Loaf site; (2) an 85 foot high earth fill dam on the Little Humboldt River at the Chimney site; (3) a combination of these two structures; and (4) an installation of two 60 inch diameter pipes through the Sand Dunes for drainage of Gumboot Lake. A negative report on the above plans was filed by the Corps in 1961.

United States Geological Survey

A *Compilation of Records of Surface Water of the United States Through September 1950, Part 10, The Great Basin*, WSP 1314, is available from the U.S. Geological Survey, Surface Water Branch, presenting monthly and yearly summaries of streamflow. These streamflow records also are issued as separate publications for individual years. Included with these data are some records furnished by other Federal, State, and private agencies.

In addition to the dam sites studied by the Corps of Engineers, the U.S. Geological

Survey investigated sites in the sub-basin which included: (1) Hardscrabble, on Martin Creek in Section 28, T. 43N., R. 41E; (2) Hot Spring, on the Little Humboldt River in Section 20, T. 41N., R. 41E; (3) Greeley Flat, on the North Fork of the Little Humboldt, in Section 23, T. 44N., R. 42E.: and (4) Latons Spring, on the South Fork of the Little Humboldt River, in Section 1, T. 41N., R. 43E.

State of Nevada

Ground Water in Paradise Valley, Humboldt County, Nevada, Water Resources Bulletin No. 10, published by the State Engineer of Nevada in 1949 in cooperation with the U.S . Geological Survey, is an evaluation of the ground water resources in Paradise Valley of the Little Humboldt Sub-Basin.

Irrigated Lands of Nevada, Nevada Agricultural Experiment Bulletin No. 183, published in 1949, has a partial inventory and classification of the irrigated lands of the Little Humboldt Sub-Basin.

Irrigation Waters of Nevada, Nevada Agricultural Experiment Station Bulletin No. 187, published in June 1953, is a compilation of analyses of samples in the Little Humboldt River area. Samples were taken at 14 sites.

Numerous other Nevada Agricultural Experiment Station Bulletins concerning agriculture in the sub-basin also have been published.

The Humboldt River Research Project, a State of Nevada sponsored cooperative program initiated in 1959, is designed to gather information on land and water resources of the river basin. A research site along the Humboldt River at Winnemucca has been set up to measure evapotranspiration from tanks in which are planted sedges and phreatophytic shrubs and grasses. By correlation of climatological factors the evapotranspiration data obtained can be extended to other areas in the Humboldt River Basin, including the Little Humboldt Sub-Basin.

Other Studies

An investigation of the geology of the Santa Rosa Range in the vicinity of Paradise Valley, by Robert R. Compton and others, was started in 1952, under the auspices of the Geological Society of America. The results of the Study were published in the September 1960 issue of the Bulletin of the Geological Society of America, Vol. 71, pages 1383-1416. This constitutes, according to Compton, the first published geologic study of the Santa Rosa Range itself, and is a very detailed and technical description of the geologic formations comprising the Santa Rosas, from Bloody Run Peak north to Granite Peak.

LAND AND WATER USE

Land Status

Status of the Little Humboldt Sub-Basin lands is as follows:

Land Status	Square Miles	Acres
National Land Reserve	1,114.0	712,960
National Forest	204.0	130,560
Railroad	15.0	9,600
Privately owned	387.0	247,880
State	8.6	5,500
Total	1,728.6	1,106,500

There are approximately 67 land owners in the Little Humboldt Sub-Basin according to records in the Bureau of Land Management District offices (N-1 and N-2), the Soil Conservation Service Work Unit office at Winnemucca, and the Humboldt National Forest office at Elko. Thirty-five of these are either small ownerships, mining companies, or land speculators, and 32 are larger owners. The irrigated land is owned by some 26 ranchers. Twenty-three owners have Bureau of Land Management grazing licenses (1960), and 23 owners have Forest Service term grazing permits.

Land Use

The national forest lands in the sub-basin are used for domestic livestock and wildlife range, for recreation, and also are the principal water yielding areas. They provide approximately 30,000 AUM's of summer grazing for cattle.

The national land reserve lands are used primarily for spring-fall grazing for livestock; however, some use is authorized in the winter and summer. These lands furnish forage for approximately 58,000 AUM's of cattle, 2,000 AUM's of horses, and 4,000 AUM's of sheep. Recreational use of these lands is increasing, and localities such as the Snowstorm Mountains also are significant water producing areas.

Of the 247,880 acres of private land, approximately 35,000 acres are irrigable. The remainder, 212,880 acres, are used for production of range forage. Practically all of the irrigated land is used to produce winter feed for livestock. Forage crops are alfalfa, legume-grass, native meadow, and small grains. Small acreages of corn, alfalfa seed, and potatoes also are grown.

Water Rights

Water rights in the Little Humboldt Sub-Basin were established by the E. P. Carville Decree of 1935. In general, the decree provides for a flow of 1.0 c.f.s. per 100 acres of decreed land, or at rates proportional to this. When water is available Class A rights are for the delivery of water at this flow rate for a period of 180 days, March 15 to September 15, or a total water diversion during the season of 3.6 acre-feet per acre. Class B rights are for 90 days, March 15 to June 13, for a total of 1.8 acre-feet per acre. Class C rights are for 45 days, March 15 to April 28, for a total of 0.9 acre-feet per acre.

There is a total of 30,361 acres with Class A rights, 1,539 acres with Class B, and 10,087 acres with Class C, for a total of 41,987 acres with decreed water rights within the Little Humboldt Sub-Basin.

Definition of Water Right Classes, and Their Water Duties

Class A - Harvest crops	3.6 acre-feet per acre
Class B - Meadow pasture	1.8 acre-feet per acre
Class C - Diversified pasture	0.9 acre-feet per acre

There are certain special cases among the rights in this basin, including displacement of class by priority or source of flow, or both, but the above general provisions govern the large majority of cases. Water from the several tributaries is frequently co-mingled, and certain rights are based on recognition of this factor. After the various tributary streams enter Paradise Valley their water is frequently diverted into common canals and ditches and so mixed that it is impossible to ascertain the specific source of the irrigation water being used on a particular plot of ground. This is especially true during high water periods. To this extent at least, use of the water of a particular tributary is not necessarily confined to lands within the physical boundaries of the drainage area ascribable to this tributary, once it has entered the main valley.

Water Use

Surface Water

Water required annually to satisfy these rights, measured at the point of use, totals 121,000 acre-feet. The total gross supply, measured at the apex of the irrigated area, is estimated to average 68,600 acre-feet annually.

The irrigated lands in the Little Humboldt Sub-Basin are located principally along the north-south trending valley floor of Paradise Valley. The valley floor, which ranges in altitude from 4,300 to 4,600 feet, is about 36 miles long and 8 miles wide and thus contains an area of about 184,320 acres. The irrigated lands are concentrated in the northern, or upper, end of the valley and in the central portion. Lands of the lower portion of the valley floor receive surface flows of irrigation water only during very wet years.

Streamflows in excess of channel capacities spread out over the meadowlands at the upper end of the valley. These flows are gradually absorbed by the valley lands as the water flows southward along the valley floor. The lands function as a giant sponge. Only in exceptionally wet years are streamflows large enough to satisfy ground water recharge capacities, accumulated soil moisture deficiencies, fill all of the depressions and sloughs, and reach Gumboot Lake at the lower end of the valley. To the extent feasible, and particularly during years when seasonal flows do not exceed channel capacities, the waters are systematically diverted, in accordance with priority of rights, at successive downstream points until the entire flow of the streams plus all return flow is exhausted.

The maximum acreage of land irrigated is estimated to be 35,000 acres. The actual number of acres irrigated in any one year is dependent upon the combined flow of the streams reaching the valley floor. Annual variations in flow of the streams are large.

The native hay and pasture receives but one irrigation in most years. This irrigation occurs during the spring runoff. There are some small acreages of native hay which receive additional water from base stream flow. This water is primarily used, however, for the second irrigation of 820 acres of alfalfa and for stockwater.

After entering the valley the surface water is dissipated by (1) infiltration to the ground water by direct seepage from stream channels and ditches; (2) deep percolation of irrigation water; and (3) evapotranspiration.

Field irrigation efficiencies are and will continue to be quite low under present management conditions, probably 20 percent or less. It would be difficult to make any estimate of off-farm conveyance losses at this time. The on-farm losses, including ditch leakage and spillage, waste, etc., are quite high. There is some recapture of surface losses.

Ground Water

Ground water supplies have been developed primarily for domestic and stock use. There are approximately 100 pumped wells in the valley which were developed for these purposes. Most of the wells have a capacity of about five gallons per minute. About 12 have capacities of some 50 gallons per minute.

There are about 18 wells in the valley which have been developed to irrigate alfalfa and other cultivated crops, most of which have been installed in the last 10 years. Some 12 wells are now in operation, with discharges estimated at from 1,000 g.p.m. to 2,700 g.p.m.

The average annual ground water recharge is estimated to be about 45,900 acre-feet. This water is discharged by (1) evapotranspiration, 42,700 acre-feet; and (2) underground flow to the Humboldt River, 3,200 acre-feet (Bulletin 10, Loeltz et al). (See Table 1; see also Land Use and Phreatophyte Map, Appendix 1.) Recent studies by the U. S. Geological Survey in the Humboldt River Research Project placed the underflow at near 1,000 acre-feet. This study was made subsequent to the U. S. Department of Agriculture Field Party investigations.

Irrigation Methods

Water use and irrigation methods are dictated largely by the nature of the water supply and the type of agriculture of the area. Except for diversion structures and channel improvements on individual farms, there are few significant surface irrigation developments in the sub-basin.

Irrigation is principally by an extensive type of flooding. Since water supply is variable, regulation of irrigation water is difficult. In some instances, ditch arrangements, headgates, and field topography permit systematic regulation of water sets. In most instances, however, the application of streams to large acreages of low-yielding meadowland does not justify spending much time per acre in irrigation. Most ranchers attempt to get available water over as many acres as possible.

Limited use has been made of the corrugation and border methods of irrigation on grain and alfalfa lands served by well and surface water. The area so irrigated, however, is not significant compared with that flood irrigated.

Data from the 1950 Census of Irrigation indicate that 12,113 acres were irrigated by water of the Little Humboldt River in 1949. Of the 22 irrigation enterprises listed, all except one were single farm systems. On the average, 551 acres were irrigated per enterprise. Twenty-one of the 22 enterprises used only surface water by gravity, flow, and one utilized pumped ground water only. The total cost of water per irrigated acre was given as 75 cents in the 1950 irrigation census.

THE AGRICULTURAL INDUSTRY

Little Humboldt Sub-Basin agriculture is dominated by the range livestock industry. Currently, livestock enterprises consist almost entirely of production and sale of feeder-type cattle. During recent years, the trend in beef enterprises has been toward a weaner calf operation, wherein calves are sold rather than carried for later sale as yearlings or two-year-olds.

Table 1. -- Phreatophyte acreage and annual ground water use, Little Humboldt Sub-Basin

Species	Height class.	Density	Acreage range types	Acres irrigated hay & meadows	Annual ground water use (feet)	Annual ground water use (acre-feet)
Black greasewood	0'-3'	.15-.20	15,300	-----	.25	3,800
	3'+	.20-.40	3,200	-----	.40	1,300
Rubber rabbitbrush	3'+	.20-.40	7,000	-----	.40	2,800
Willow	5'-8'	.25-.40	3,400	-----	2.30	7,800
Silver buffaloberry	10'-15'	.20-.50	1,000	-----	1.50	1,500
Saltgrass	-----	.20-.30	11,200	-----	.50	5,600
Great Basin wildrye	-----	.20-.50	3,100	-----	1.00	3,100
Great Basin wildrye	-----	-------	------	5,000	.50	2,500
Creeping wildrye	-----	.20-.50	6,300	-----	1.00	6,300
Creeping wildrye	-----	-------	------	5,100	.50	2,500
Alkali sacaton	-----	.20-.50	8,400	-----	.50	4,200
Alfalfa	-----	-------	------	2,550	.50	1,300
Totals			58,900	12,650		42,700

Source: Humboldt River Basin Field Party.

The January 1, 1960 inventory of all cattle on sub-basin ranches is estimated at 27,000 head. Major shifts in the relative numbers of cattle and sheep have occurred during recent years. Sheep, numerous on sub-basin ranches in 1937, declined rapidly and were completely eliminated by 1960. The number of cattle steadily increased from 1930 to 1959. A sharp decrease in cattle numbers occurred during 1960.

The national forest and national land reserve lands provide most of the spring and summer feed for the breeding herds. The grazing season on the national forest extends from May to September, with July and August being the principal months. Domestic livestock graze on the national land reserve in the spring and fall; summer and winter grazing also is authorized, but to a lesser extent. The public and intermingled private range lands provide about 5 1/2 months of the total livestock feed required. The balance of feed is provided by about two months of grazing on crop aftermath, irrigated and dry pastures, and about 4 1/2 months on hay. The hay required for winter maintenance of the herds is dependent upon the severity of the winter, the amount of snow accumulating on the valley floor, and the supply of forage available for grazing on the valley lands.

Cropland acreage harvested varies widely. Weather, water supply, and other annual crop - production hazards often intervene to overshadow managerial decisions in determining actual acreages of crops harvested. Lack of a dependable water supply is the greatest production hazard in the sub-basin. Years of lowest acreage of crops harvested coincide closely with years of low streamflow.

Agricultural Income

Approximately 95 percent of gross agricultural income in the sub-basin has been from the sale of range livestock and livestock products. Gross income, derived from the sale of livestock products, primarily beef, amounted to an estimated $754,000 in 1954 and sale of crops to $29,000.

Information on net farm income is not available for sub-basin ranches. Data for the State reveal that net farm income amounted to 30 percent of gross income in 1954. While the percentage of gross income that is retained as net income has varied considerably, the trend has been downward over most of the last decade. This reflects the price-cost squeeze that is developing in agriculture.

Markets

The livestock shipped from the sub-basin constitute the only agricultural export of significance.

Cattle sold by sub-basin ranchers are chiefly weaner calves, yearlings, and cull cows consigned to feed yards in neighboring States. It is estimated that more than 80 percent of these cattle go to California, principally feed lots in the San Joaquin Valley. Less common markets are the feed yards of southern Idaho and Oregon. All of these are expanding markets, particularly those in California.

Most young stock is sold on the ranch to outside buyers and shipped to destination by truck at the buyer's expense.

Cull cows and a few small lot shipments of other cattle are taken to the livestock auction at Fallon, Nevada. In most instances these livestock are hauled by the ranchers themselves.

So far there have been no significant outshipments of grain or hay from the sub-basin. Grain is usually grown for ranch use and surplus hay is carried over from year to year.

Transportation

Transportation facilities are readily available to sub-basin ranches. Two interstate rail lines, Southern Pacific and Western Pacific, serve the area, providing daily schedules from Winnemucca to the West Coast and to Ogden and Salt Lake City and points east.

Several common motor freight carriers maintain terminals in Winnemucca and provide interstate service to all parts of the nation. At least one local carrier provides intrastate service.

Transcontinental U.S. Highway 40 links Winnemucca and Paradise Valley with all eastern and western points, and U.S. Highway 95 provides convenient access to southern Oregon and Idaho. Two major bus lines offer daily schedules over U.S. 40. State Highway 8B connects with U.S. 95 and provides a well-maintained paved surface road between Winnemucca and the town of Paradis Valley.

Livestock transportation service is provided by local truck carriers as well as by a number of truck carriers from Idaho and California. Both railroads serving Winnemucca also offer this service.

Trend in Number of Ranches

The number of ranches in the sub-basin is currently declining. The Little Humboldt Sub-Basin comprises approximately 18 percent of the land area and contains about a third of the land irrigated in Humboldt County. U.S. Censuses of Agriculture show that ranches increased in number from 1920 to 1940. Since 1940 the number of ranches has steadily declined.

The number of commercial ranches in the area declined by more than 50 percent between 1945 and 1960. Approximately three-fourths of the ranches in 1960 were classified as commercial.

Trend in Size of Ranches

Ranches in the Little Humboldt Sub-Basin are increasing in size. In 1960 the average acreage per ranch in the sub-basin was about 8,000 acres. During the depression period of the 1930's and the wartime period of the 1940's, ranch size changed very little. Since the end of World War II, however, acreage per ranch has increased greatly. Acreage per ranch has quadrupled during the last 15 years.

There are a number of reasons for the recent increase in size of ranches. Cost-price problems of recent years have encouraged a constant search for economies in operation. The extensive range livestock ranches in the sub-basin are particularly conducive to economies of scale. Technology, a major factor in a number of agricultural changes, has influenced expansion in ranch size. The use of more efficient equipment and methods makes possible additional work with the same number of man-hours. The cost of new innovations, a fixed expense, must often be spread over a larger numbers of acres to be economically justified.

Coincident with the introduction of technological advances and scale economies is the need for additional capital. Availability of long-term capital in recent years has been a great help in meeting these needs. Another source of capital has been from outside investment. Both have helped to make consolidation of ranches possible, which in turn has been encouraged by economic pressures.

According to preliminary agricultural census information for 1960, the average investment in land and buildings per ranch in the sub-basin area was about $145,000. Capital investment in land and buildings has varied widely, declining from more than $41,000 in 1920 to about $12,000 in 1940 and then increasing rapidly during the last 20 years. In addition to investment in land and buildings, large amounts of capital in the form of livestock, machinery, equipment, and supplies are required for ranch operations.

In 1959, a third of the commercial ranches in the sub-basin sold agricultural products with a dollar value in excess of $25,000. Ten years before, less than 18 percent of commercial ranches had sales valued at more than $25,000. It is apparent that the percentage of ranches with higher values of sales has increased rapidly.

Ranch Tenure

Most of the ranchers in the sub-basin own the land they operate. The number of ranchers owning all the land they operate has averaged more than 70 percent since 1900. However, the trend for the recent 20 year period has been toward fewer full owner, more part owner, more manager-type operations, and a considerable decrease in the number of tenant-operated ranches. In addition to land operated, most ranchers hold permits to graze livestock on Federal lands.

Water Supply-Production Relationships

An economic appraisal of the value of irrigation water requires the establishment of an estimate of crop yield response to water use. The problem is a complex one. The wide range in water-holding capacities of the different soils, soil moisture levels required for production of the different crops, ground water levels, irrigation methods used, physical features and practical problems involved in operation of distribution systems, and variations in climatic factors result in wide variations in the amount of water required at ranch headgates to produce crops. Based on observations and limited investigations, the impact of drought and conversly the production function for water apparently involves reduction in per acre yields, reduction in harvested acreage, and adjustments in cropping patterns.

Adequate historical data on the quantity of water use, on a ranch basis, in producing crops in the Little Humboldt Sub-Basin are not available. The area is subject to extreme annual variations in the total quantity of stream flow. Frequently, channels and water-control structures are inadequate to control the high seasonal flows that usually occur from March through June.

Streamflow records constitute the principal source of reliable water-supply information. Using the continuous records for Martin Creek from 1922 to 1960 for control, estimates were developed of the total stream flow available for irrigation of lands in Paradise Valley for the period 1922-60.

Historical records of physical production of agricultural commodities in the area are limited. Records of production of the principal agricultural crops harvested are available for Humboldt County by five year intervals from the U. S. Census of Agriculture. The Statistical Reporting Service has maintained annual records for estimated production of the principal crops for many years. These are available on a State basis only.

In order to establish the relationships between water supply and agricultural production in Paradise Valley, a procedure was developed wherein aggregate water supply was related to aggregate crop production and cattle numbers. The technique involved the development of estimates for the physical quantity of crops produced and estimates of the January 1 inventory of cattle numbers for the sub-basin. See Appendix I for procedure followed.

Since about 95 percent of the harvested crops in Humboldt County and in Paradise Valley consist of hay crops, and because of the time limits imposed, estimates were developed for hay crops only.

The annual variations in irrigation water supplies available to Paradise Valley ranchers are shown in figure 2. A three year moving average also is shown in figure 2.

The yearly relationship between total irrigation water supply and hay production is shown in figure 3. In figure 4, water supply, hay production, and cattle numbers for the 1922-60 period are graphically illustrated. The data indicate that a wide spread between cattle numbers and hay production has developed during the last decade.

The effect of variations in annual runoff on hay production is roughly indicated in figures 2,3, and 4. Hay production, of course, is affected by many additional factors, such as antecedent moisture conditions and water supplies, seasonal distribution of annual runoff, temperatures, winds, disease, insects, rodents, fertilizer, stand density, and management decisions as to when to harvest and whether to cut the hay or harvest it by grazing livestock.

In order to modify the effect of factors other than water and thus reveal more accurately the effect of water supplies on hay production, the 39 years included in the study period were arrayed in order of magnitude of runoff. Yearly production of hay corresponding with the water years was also arrayed. The array of water years and hay production was then divided into four eight-year groups and one seven-year group. Means for both the water and hay groups were computed and plotted, and a curve was drawn through the plotted points (figure 5). The means of the groups and the ratio of the means between runoff and hay production are shown in the following tabulation:

Group	Mean runoff 1/ acre-feet	Mean hay production tons	Ratio Acre-feet per ton
1	23,891	9,431	2.54
2	37,872	13,111	2.89
3	49,235	14,815	3.32
4	71,008	16,108	4.41
5	127,353	15,377	8.28

1/ Based on a preliminary estimate of flow into Paradise Valley.

Figure 2. - Total Yearly Runoff, Paradise Valley, Nevada, 1922 - 1960. 1/

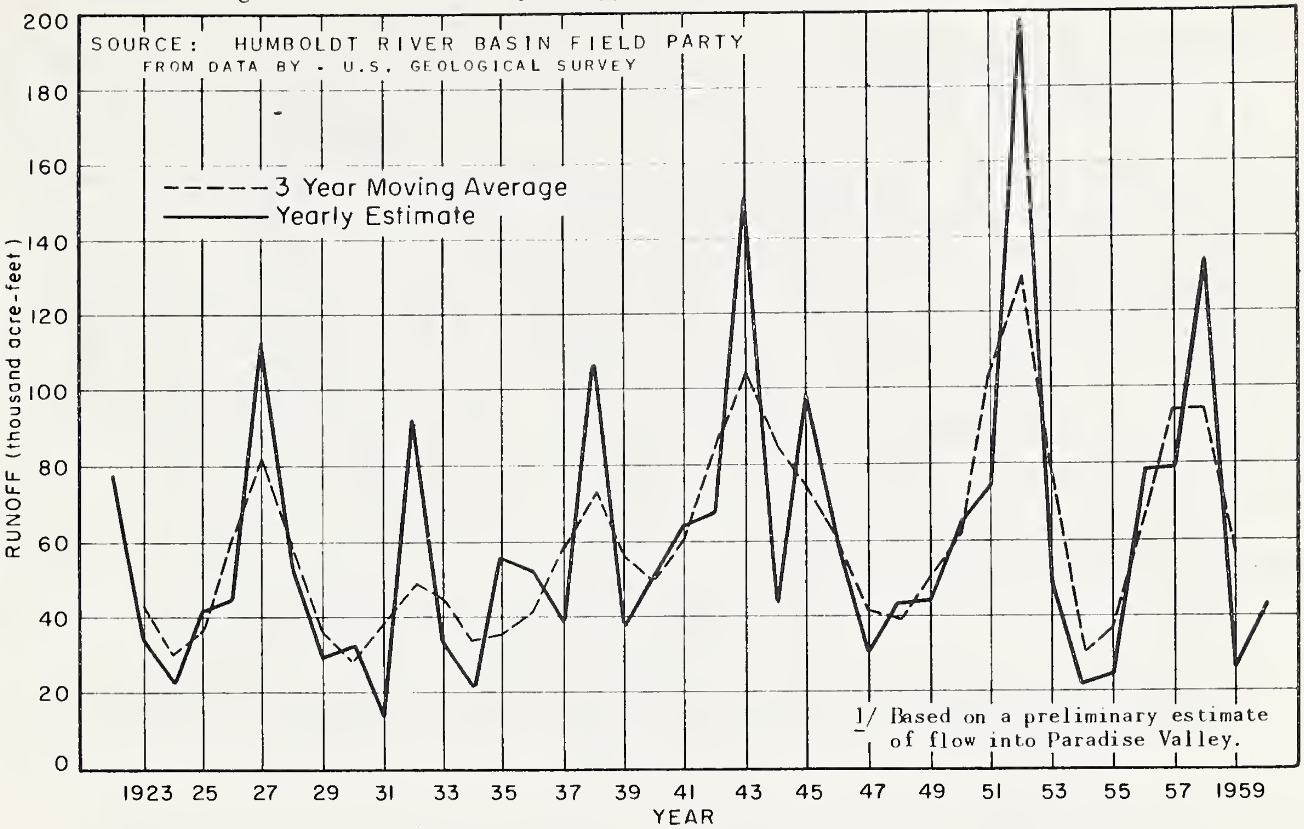


Figure 3. - Irrigation Water Supply and Hay Production, Paradise Valley, Nevada, 1922 - 1960

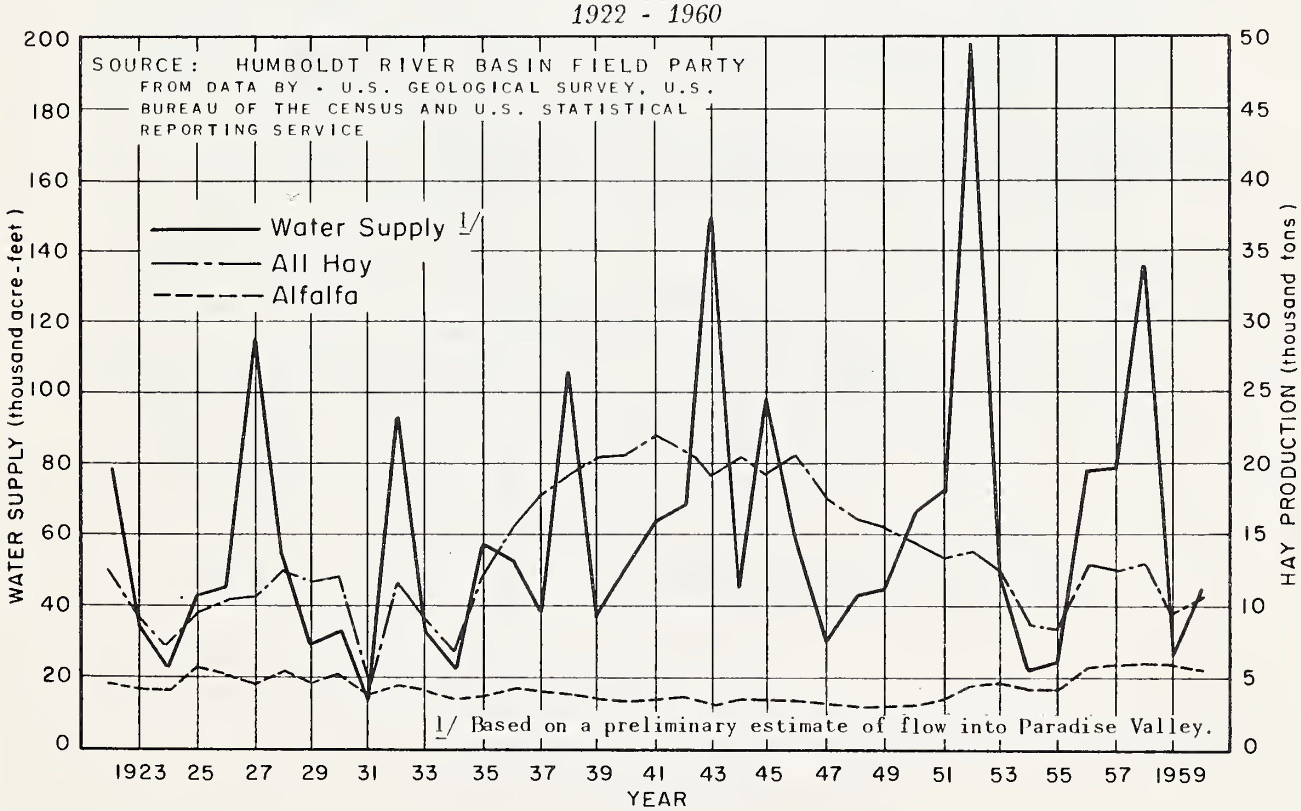


Figure 4. - Irrigation Water Supply;[1/] Number of Cattle January 1, and Hay Production, Paradise Valley, Nevada, 1923 - 1960.

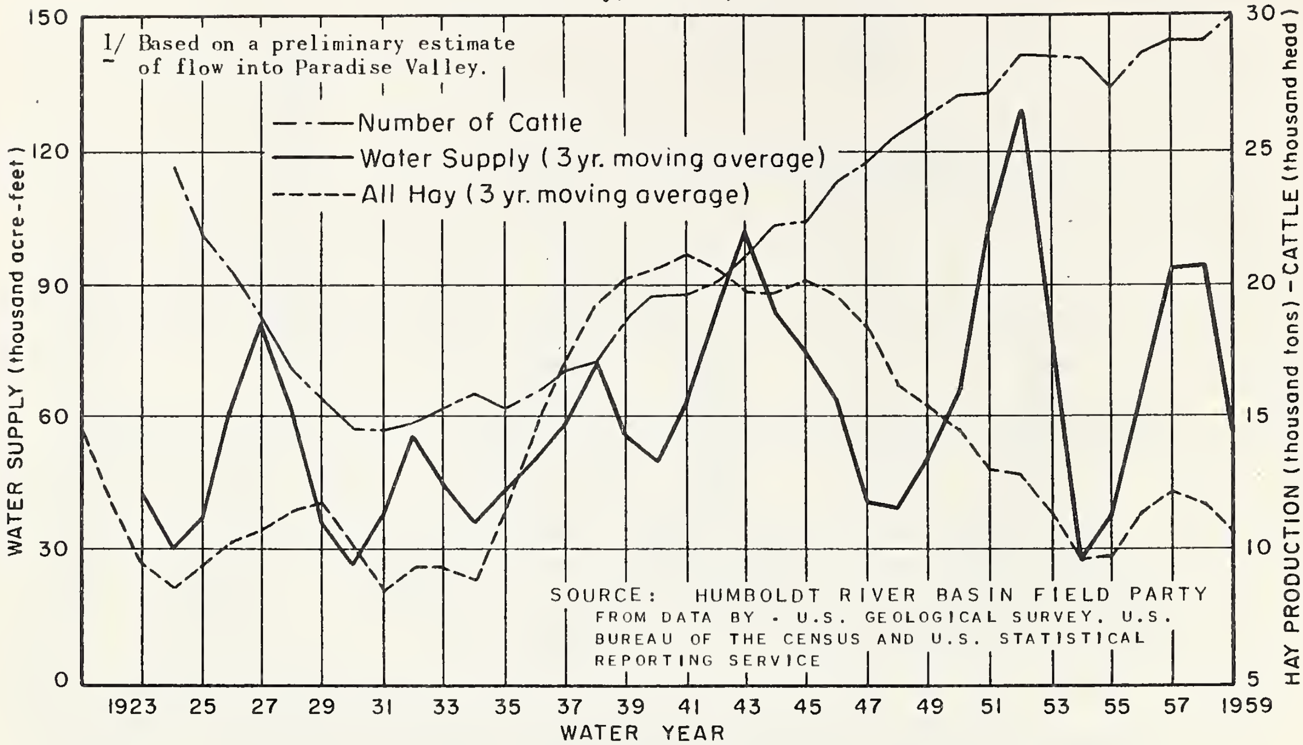
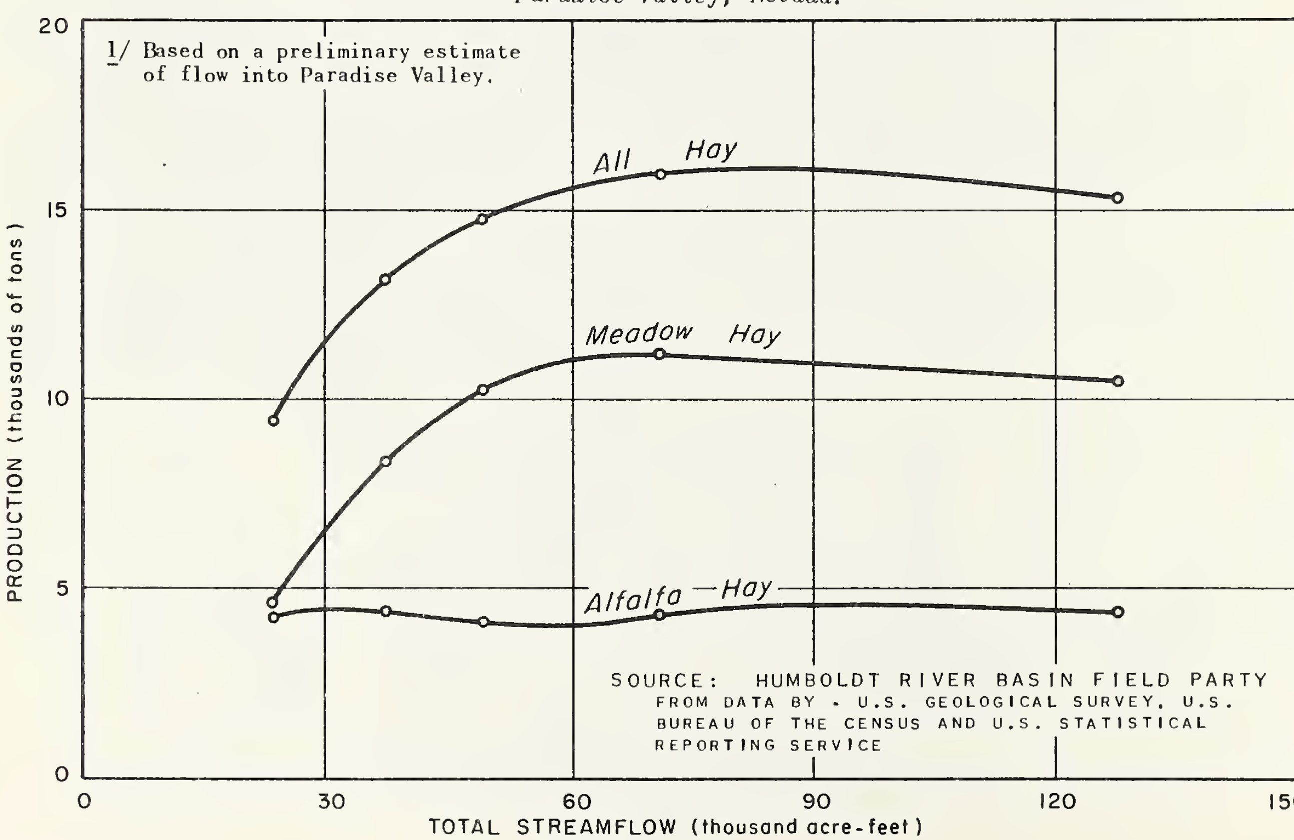


Figure 5. - Relationship Between Streamflow[1/] and Hay Production, Paradise Valley, Nevada.



The production function for water indicates that hay production increases as runoff increases until runoff reaches about 80,000 acre-feet, after which hay production begins to decrease with additional runoff.

Production of irrigated crops, other than forage cut for hay, was not considered in this analysis, because other harvested crops, primarily grains, have relatively minor significance. Other than hay, irrigated pasture is by far the most important crop in the sub-basin. Yields on irrigated pasture are not available. The technique illustrated for hay can be adapted to measure indirectly the combined value of hay, pasture, and grain by using information on the number and weight of cattle sold. It would also be necessary to establish the proportion of the total annual beef herd forage requirement that is produced on the irrigated lands.

The investigations to date have been helpful in identifying the broad aspects of some of the problems involved. The more important of these are listed below. The problems listed are concerned primarily with the physical and institutional factors, verification of which depends primarily upon technical disciplines other than economics. Establishment of their true character, however, is basic to an economic appraisal of the efficiency of the current use pattern of the land and water resources and the identification of possible modifications of the use pattern that might result in improvements in economic efficiency of use.

Establishment of the broad physical, institutional, and economic factors provide the basic framework of information essential to the identification of desirable physical improvements, their direction and magnitude, and their economic effects. These include:

1. The total quantity of stream runoff during the 1922-60 period was inadequate to satisfy fully the existing water rights. Any project or programs that will affect the regimen of the streams will need to be accompanied by appropriate adjustments in existing water rights by the local water users if equity among the people in the sub-basin is to be realized.
2. Runoff of the streams constitutes the only source of irrigation water in the sub-basin. The work of the U. S. Geological Survey shows that ground waters are directly related to surface waters. Underground outflow, measured during September-October 1947 and expanded to the full year, was estimated to be 3,200 acre-feet. Except for the underground outflow and the infrequent surface outflow, the entire flow of the streams is consumed within the sub-basin through the evaporation and transpiration processes. For an average water year, disposition of the total runoff was estimated to be as follows: About 9.9 percent evaporated from water surfaces; 46.2 percent was consumptively used by irrigated crops, 39.3 percent was consumptively used by saltgrass, rabbitbrush, greasewood and willows; and 4.6 percent was underground outflow. The opportunity for improvement rests largely in what can be done to decrease non-economic consumptive uses and to increase economic consumptive uses.

3. Ground water aquifers underlie the valley floor. The aquifers function as storage reservoirs for high seasonal streamflows. Ground water levels rise in early spring, reach their highest level usually about April, then gradually decline as the water is depleted by vegetal growth and slow drainage until about October. During high runoff years water levels, augmented by surface streams, rise above the land surface in the vicinity of the channels for extended periods of time. During moderate runoff years ground water levels rise within 3 feet or less of the land surface. During low runoff years ground water levels rise moderately in the upper part of the valley floor, with levels falling in the lower part of the valley. The integrated development of the water supply, surface and ground waters, and the effective utilization of the ground water aquifers should aid materially in attaining increased efficiency of water and land use in the sub-basin.
4. Ground water levels in the presently irrigated areas limit the acreage suitable for production of alfalfa and other crops which ecologically and physiologically are not adapted to sites in which ground water levels occur near or above the land surface for any length of time.
5. Alfalfa and other crops obtain part of their water supply from ground water when it is present at reasonable depths. Preliminary information indicates this situation exists in the sub-basin and explains the relatively satisfactory yields of alfalfa and meadow hay, with one surface irrigation, on those lands where ground water levels fluctuate within depths tolerable to the kind of crop grown.
6. The presence of some 11,000 acres of saltgrass in the trough of the valley immediately below the more productive irrigated lands indicates excessive accumulation of salts in the surface soils. It is essential that water-improvement plans incorporate provisions to relieve or prevent detrimental accumulation of salts in the surface soils of extensive areas of the irrigated lands.
7. The wide variations in the annual runoff of the streams are associated with wide variations in the annual quantity of hay produced. The prolonged flooding of the irrigated lands during extremely wet years reduces the quantity and quality of hay produced. During dry years, production of hay is drastically curtailed. Both of these situations impose difficult and costly adjustments in ranch management. To some extent, ranchers have modified the impact of variation in water supply by storing hay produced in good years for use in poor years.
8. The climatic phenomona of wet and dry cycles are also associated with the necessity of making, at periodic intervals, major adjustments in numbers of livestock, game animals, and other wildlife. The adjustment from dry cycles to wet cycles is accomplished with ease. During years of above-average precipitation, with proper management range forage production is gradually increased. Irrigation water supplies become adequate for expansion of irrigated acreage and production of plentiful supplies of winter feed. The favorable environment is conducive to a gradual increase in numbers of livestock, big game, and other wildlife and to over-capitalization of the land and water resources.

   The adjustment from wet cycles to dry cycles, however, has been accomplished historically by widespread distress and large financial losses. At the beginning of a dry cycle, the numbers of livestock, big game, and other wildlife built up during the wet years are maintained at relatively high levels until the accumulating effects of the drought force adjustments. These accumulated effects are usually triggered by

the occurrence of a particularly adverse year, extreme drought during the summer, a severe winter, or a combination of both.

Measures which will modify the impace of the dry cycle and the development of criteria which will help the people in the basin to make the necessary adjustments with minimum losses should be incorporated in plans for the future agricultural use of the land and water resources in the basin.

Economic Framework for Evaluation

Factors such as those listed below will have some impact on the future needs for water and on the economic value of its use in the basin as a whole, but in such a small area the nature and extent of the impact is difficult to evaluate. Suggestions for improvements should be made with an awareness of them. Such factors are:

1. The combined effect on national requirements for agricultural products of projected population growth, improved dietry standards, and expected shifts in foreign exchange of agricultural products.
2. Shifts in economic advantage between regions of the country for production and marketing of major classes of agricultural products.
3. Growth of nonagricultural uses of the land and water resources, depletion of resources now used for agricultural production, retirement of inferior land from agricultural use, and the probable effects of these factors on the availability of land for agricultural production.
4. Advancement in agricultural production technology resulting from research, educational, and technical assistance programs, and the resulting increase in production and utilization of crops and pasture.
5. Opportunities for resource development, with expected levels of agricultural output and costs.

An essential first step is the establishment of the current situation with respect to the agricultural use of the land and water resources as a means of identifying some of the problems involved, which in turn indicate opportunities for adjustments and improvements.

WATER-RELATED PROBLEMS IN THE SUB-BASIN

Agricultural Water Management

Control of Water

There are a number of uncontrolled diversions (tight dams) and brush-trash accumulation areas in the creek channels that force stream flows into ditches, or over the land when the runoff is above normal. It is difficult to regulate the stream and ditch water with these obstructions. In recent years a few concrete diversions and headgates have been installed.

Some ditches do not have the necessary structures to control the water, either from the diversion or onto the fields. More ditches are required for better water distribution.

Seasonal Distribution of Water

The irrigated lands receive but one irrigation during the spring runoff because there are no provisions for seasonal distribution. Available water, under these conditions, is spread over

large acreages of land that produce low per acre yields of hay and pasture. High yielding good quality forage requires periodic irrigation throughout the growing season. Storage capacity is needed to distribute available water supplies on this basis.

Irrigation Efficiency

Field irrigation efficiencies are quite low in the sub-basin. Fields are irrigated from a system of parallel gradient ditches, which is a type of controlled flooding. Water flows over the land between ditches without guides or restrictions. The water concentrates in low areas, leaving high spots dry.

Soils

The soils in the irrigated valleys are mostly deep, medium textured, and imperfectly drained. They vary in saline and alkali content from none to high. The problem soils are those with high salinity or alkali where the only plant cover is greasewood or some salt tolerant grass. The soils slightly to moderately affected by these salts present a continuous problem of maintaining and improving crop yields. Most of the irrigation is on the better soils.

Seepage Loss

Soils in the irrigated area predominantly have above average infiltration characteristics, although the rate of water intake is affected by accumulated salts in portions of the flood plain in the lower part of Paradise Valley. The seepage loss is high in such soils, especially after being under cultivation. Water loss from ditches and creek channels is high on the alluvial fans and on the floodplains.

Drainage

Water table levels affect the type of crops that can be grown. Normally, the water table is closest to the land surface in the lower end of the valley, in the saltgrass-alkali sacaton sites. Seasonal and annual variations in the water supply result in a greater fluctuation in the water table in the north end of the valley, making ground water control difficult.

The area comprising Gumboot Lake has been inundated to some degree at least 23 times in the last 100 years. The crops grown in this area are either lost, or the yields reduced, during these high runoff periods. This area is flat, therefore drainage ditches would be difficult to install and maintain.

Flood Damage

Two types of floods have produced damage in the sub-basin. They are: (1) the wet-mantle, resulting from the complete saturation of the soil mantle; and (2) the dry-mantle. The dry-mantle flood occurs less frequently, and is usually localized at the stream sources on the higher watersheds.

The 1881, 1907, 1914, 1938, 1943, and 1952 wet-mantle floods in Paradise Valley produced erosion damage in the form of overland flows, gullying, and channel cutting along many stream courses. Sedimentation damage was inflicted on irrigation structures and ditches, roads, and bridges, as well as on buildings and haystacks. Since the 1881 flood period there

Photograph 4. - Eroding channel, Cottonwood Creek, Fred Buckingham Ranch, west of Paradise Valley town. Looking north toward Red Hills. 6-321-1 S.C.S. PHOTO

Photograph 5. - Willow phreatophyte areas in native hay meadows, Bullhead Ranch, along Little Humboldt River, looking east 6-566-1 FIELD PARTY PHOTO

has been little wet-mantle flood damage from Cottonwood Creek through the town of Paradise Valley, except for the May 1, 1938 flood, which carried away the main bridge in the town. (See Chronology of Floods, Appendix 1.)

The first damaging dry-mantle flood of record to do damage in the sub-basin occurred July 22-23, 1913. This flood period resulted from six days of heavy daily thunderstorms starting July 18, which struck practically the entire northern half of Nevada. The damage to lands in Paradise Valley was confined principally to the hay crop, then in the process of being cut. The denuded watershed lands in the Cottonwood Creek basin were damaged by sheet and gully erosion, thus preparing the way for the more serious floods of 1918.

To date the most destructive of the dry-mantle floods in Paradise Valley occurred on June 22, 1918. It was the result of a weeklong series of heavy thunderstorms on the thinly vegetated high basins and steep slopes laid bare by past watershed abuses in Cottonwood Creek and its tributaries. Damage from this flood necessitated suspension of range use on the national forest lands at the flood source for a period of 5 years (1919-1924).

The Cottonwood drainage system continues to produce sediment and channel damage from high water in the spring, as well as from summer storms (see photograph 4). This damage, still unnecessarily great, although not so severe as in past periods, resulted from the uncontrolled use and destruction of the vegetal cover on the Santa Rosa watersheds.

Martin Creek and the Little Humboldt River also have a record of flood, erosion, and sedimentation damage, but, unlike the Cottonwood drainage system, most of the damage along these two streams stemmed from wet-mantle floods, particularly those in 1881, 1890, 1907, 1914, 1943, and 1952. The 1910 flood produced damage along the Little Humboldt, but not on Martin Creek.

Vegetation - Kind and Condition

Range and Watershed

Watershed cover conditions on much of this sub-basin are far from ideal. Table 2 indicates the acreage by classes of present annual forage plant production, grouped by soils for each vegetal type and site. The rates in this table are indicative of the total annual forage production, and will be used as a basis for planning needs only. Forage production figures will not be used for assigning range carrying capacities. These carrying capacities will depend upon such factors as slope, soil depth, soil character and stability, and the management objectives of the administrative agency.

Past exploitation and abuse of the range resource, and denudation of the aspen, mahogany, and other tall browse species, have adversely affected the watershed vegetal cover. This is particularly true of most of the higher slopes in the Santa Rosas, and some portions of the Snowstorm Mountains. There, many of the woody species were almost completely removed for use in the early mines, mills, and on the ranches.

Table 2.--Acreage classes of present annual forage plant production, grouped by soils for each vegetal type and site, Little Humboldt Sub-Basin

Vegetal type and site	Annual forage plant production classes (acres)		
1. Rabbitbrush-greasewood-grass; saline bottomlands	Rates of forage production (pounds per acre) 1/ 2/		
Soil associations	850-1500	200-600	20-200
A4-H1	--------	-------	6,000
A6	--------	-------	8,000
X1-A6	--------	-------	11,000
X1-H3-Y1	--------	5,000	------
H1-H3-A6	--------	-------	15,000
H4-A4	--------	-------	13,000
Sub Total		5,000	53,000
2. Big sagebrush-grass; upland benches and terraces	Rates of forage production (pounds per acre) 1/ 2/		
Soil associations	250-600	100-450	20-150
A2-S1	-------		21,000
A2-S2-A10	-------		27,000
A7-A2-S1	6,000		1,600
A12-A6-H2	-------		5,100
B1-R1-L1	-------	500	22,000
B2-A8	1,100	200	7,000
B2-P1	-------	400	7,700
B3-P1-C1-L2	-------	14,700	132,100
C2-A11	1,000	11,500	8,800
R2-A1	-------		8,000
R4-A9	-------		9,000
S1-A2 3/	-------		4,500
S1-A2 4/	4,000		40,000
S1-R9	-------		5,000
S4-R6	-------		33,000
S6-S5	-------	14,000	27,000
S7-R9-L3	2,200	33,000	83,000
Sub Total	14,300	74,300	441,800
3. Shadscale-grass; droughty desert uplands	Rates of forage production (pounds per acre) 1/ 2/		
Soil associations	100-200	50-150	10-50
A5-A6	-------	25,900	------
A5-A6-H2	-------	-------	3,600
S2-S1	-------	-------	8,000
S2-A3	-------	5,900	12,000
Sub Total		31,800	23,600

Table 2.--Acreage classes of present annual forage plant production, grouped by soils for each vegetal type and site, Little Humboldt Sub-Basin--Continued

Vegetal type and site	Annual forage plant production classes (acres)		
4. Big sagebrush-grass; steep south and west slopes	Rates of forage production 1/ 2/ (pounds per acre)		
Soil associations	200-550	100-350	20-150
R1-L1-B1 3/	-------	8,000	14,000
Sub Total		8,000	14,000
5. Browse-aspen-grass; north and east slopes and basins	Rates of forage production 1/ 2/ (pounds per acre)		
Soil associations	300-650	150-500	50-200
C2-R8-P1	-------	3,000	2,500
R1-B1-L1	32,000	34,000	103,000
R1-L1-B1 4/	-------	3,000	13,000
R3-L2-C1	9,400	107,000	39,000
R5-S3-L3	-------	5,000	30,500
R7-C1-L2	-------	18,800	3,500
Sub Total	41,400	170,900	191,500
6. Low sage-grass; shallow sites on steep mountain slopes and tops	Rates of forage production 1/ 2/ (pounds per acre)		
Soil associations	150-400	75-250	25-100
L1-B1	-------	------	1,900
Sub Total			1,900
Totals	55,700	290,000	725,800

1/ These figures indicate total annual forage production, and will be used as a basis for planning needs only. Forage production figures will not be used for assigning range carrying capacities. These carrying capacities will depend upon such factors as slope, soil depth, soil character and stability, and the management objectives of the administrative agency.

2/ These rates represent production variance from poor years to good years. At higher elevations within the site, with greater precipitation the rates would be higher, and conversely for lower elevations.

3/ S1-A2 / 80-20 4/ S1-A2 / 70-30 5/ R1-L1-B1 / 50-30-20 6/ R1-L1-B1 / 60-20-20

Source: Humboldt River Basin Field Party.

In many places the pristine vegetal types have been thinned out, completely removed, or replaced by inferior water-holding and soil-binding plant species. This cover disturbance has in turn contributed to the augmentation of flood conditions, topsoil loss, and sedimentation damage in the lower portions of the sub-basin.

Phreatophytes

The phreatophytes in this sub-basin consist mainly of saltgrass, willows, rabbitbrush, and silver buffaloberry in the hay meadows, with greasewood in the flats along the lower Little Humboldt, and lanceleaf rabbitbrush in some of the dry meadows at the higher elevations.

The willows are generally scattered over the native hay meadows (see photograph 5). Concentrations of willows, rabbitbrush, and buffaloberry, thick enough to be a problem, are found in the upper portion of Paradise Valley, in the upper Little Humboldt, and along the main stem of the Little Humboldt between the Hot Springs and the junction of the North and South Forks. An estimated 3,400 acres here have a concentration of willows that would justify eradication and control methods.

There is a long strip of greasewood (under three feet) to the west of the hay meadows in Paradise Valley. This area lies between Sheldon Lane and Gumboot Lake. It comprises about 15,000 acres of 55 percent greasewood composition, and is of some significance from the standpoint of consumptive water use (see table 1).

Fire Protection

Fire has been of considerable significance as a causative agent of watershed damage and deterioration, particularly on the southern reaches of the Santa Rosas. The Paradise Hill and Paradise Valley fires of 1940 left a 17,000 acre scar on the Santa Rosa watershed which is still plainly evident. With deterioration of the original plant cover, whether caused by fires or other abuses to the watershed, the resultant vegetation providing flashy fuels may often increase the hazard.

As time goes on, risks of fires caused by the steadily increasing recreation and hunter use of the watershed wild lands, not only on the national forest and national land reserve, but also on the privately owned lands, will continue to mount. The importance of these lands as water yielding areas, particularly the national forest lands in the higher Santa Rosas and the national land reserve lands in the Snowstorm Mountains and the lower Santa Rosa watershed areas, makesfire protection a factor of continuously increasing importance here. Prevention or prompt supression of potentially disastrous range or forest fires is now and will continue to be an important facet in proper resource and watershed maagement in the sub-basin.

RECREATION AND WILDLIFE

Recreation Developments

At present the Martin Creek campground on Road Creek is the only such facility on the Humboldt National Forest within the sub-basin. Another campground is in the process of construction on Lye Creek. There are no developed campgrounds or recreation areas on the national land reserve lands. Plans for future developments are shown in table 19, Appendix I.

Wild Life

Hunting and fishing are very important facets of use on the national forest and national land reserve, constituting the primary purpose for recreation visits. The following table, compiled from the 1960 annual wildlife report for the Paradise Valley Ranger District, provides information on Game Management Area No. 5 (that portion of Humboldt County east of U.S. Highway 95 and north of the Western Pacific tracks). The Nevada State Fish and Game Commission estimates that 75 percent of the deer killed each year in that area are taken from the Ranger District.

Table 3. --Estimated hunting and fishing use, Game Management Area 5, 1959

Species	Big game			Number fishermen	Number small game hunters
	Population	Number killed	Number hunters		
Antelope	150	34	1,800	2,000	500
Deer	6,000	884			

Source: Nevada State Fish and Game Commission.

Statistics for the 1960 season show an increase in deer kill to 1,086 head; 688 bucks and 398 antlerless deer. The number of deer hunters, and the number of deer taken, would undoubtedly be much larger if the sub-basin area were open to out-of-state hunters, as is Elko County. Also, it has only been within the last twenty years, since 1941, that antlerless deer hunting has been permitted in the Santa Rosas. As a consequence, the deer population is much higher than is desirable from the standpoint of its effect on cover.

WATERSHEDS WHICH DO NOT APPEAR TO HAVE OPPORTUNITIES FOR PROJECT-TYPE DEVELOPMENT

The area of land along the east drainage of the Santa Rosa Range south of Lamance Creek to the Sand Dunes includes a number of small drainages with problems that do not lend themselves to project-type treatment. These streams are ungaged but do furnish some early irrigation water. The lands irrigated are on the alluvial fans over which the streams flow. The infrequent floods on these streams are due mostly to summer convection-type rainstorms. With few exceptions, each of the streams furnishes water to one ranch unit only, unless the volume of runoff is large enough to reach the terrace lands and bottom lands of the valley.

Eden Valley and the lands east to the South Fork, the west slope of the Hot Springs Range, and the area between the North Fork and Martin Creek watersheds are not suited to project development. In only two years (1890 and 1910) has any flooding originated primarily in the low hills of the Little Humboldt River, which includes these drainages (see Chronology of Floods, Appendix I).

The west slope of the Hot Springs Range and the land described in the preceding paragraph are droughty areas used mostly for range. The drainages from the Hot Springs Range have channelized over the years from summer convection storms, with some runoff from spring snow-melt during the better moisture years. There is no evidence of any attempt to use runoff from this area for irrigation except what might be intercepted by existing conveyance ditches.

Lands in the Little Humboldt Sub-Basin can be treated or can receive aid for treatment under existing U. S. Department of Agriculture and other Federal and State programs. The regular programs of the two Federal land administering agencies, the Forest Service and the Bureau of Land Management, provide a means to accomplish needed range, recreation, and watershed development on Federal lands which they administer. The owners of private lands can receive aid under various programs of the Department of Agriculture.

Technical Assistance and Cost-Sharing

Under the provisions of Public Law 46 the Soil Conservation Service furnishes technical assistance through Soil Conservation Districts. Under this program, assistance in developing coordinated conservation plans and in applying conservation measures may be furnished for farms and ranches. These plans provide for land use adjustments, erosion control, water conservation, irrigation, drainage, and flood prevention. Solution to the sub-basin problems on private land may be arrived at in part by the use of such technical assistance, and through cost sharing under the Agricultural Conservation Program, administrated by the U. S. Agricultural Stabilization and Conservation Service.

Agricultural Water Management

Opportunities for irrigation improvement on individual ranches are common throughout the sub-basin. Treatments for various types of problems are listed below.

Problems	Suggested Treatment
1. Water distribution systems	a. Remove "tight dams" and install controlled diversions. b. Construct needed gradient supply ditches. c. Line ditches through highly permeable soils. d. Construct necessary control structures.
2. Low efficiency use of water	a. Level land for even distribution of water. b. Reorganization of irrigation systems. c. Line ditches through highly permeable soils. d. Do not irrigate fields when the soil is saturated with water. e. Establish high producing crops suitable for conditions.
3. Water supply	a. Do not irrigate fields when the soil is saturated with water. b. Remove "tight dams" and install controlled diversions and structures. c. Construct overnight storage reservoirs. d. Line lateral ditches. e. Drill irrigation water wells. f. Replace pheatophytes with better vegetation.

Vegetal Improvement

Evidence of watershed erosion and consequent mining of soil and vegetal resources on privately owned land indicates the need for action to reverse the trend toward land deterioration. Each of the following treatments would contribute in some measure to improvement of species and cover.

Problems	Suggested Treatment
Irrigated lands	
1. Low yields	a. Establish better yielding forage crops suitable to conditions for hay and pasture. b. More efficient use of water. c. A fertilization program.
Non-irrigated land	
1. Range condition on decline or static.	a. Practice rotation-deferred grazing. b. Use of irrigated pastures to supplement available range. c. Reseeding. d. Proper use.
2. Management	a. Fencing to enable better livestock distribution and proper range use. b. Salt and water distribution.

Photograph 6. - Phreatophyte Removal, Robert Thomas Ranch, Paradise Valley. This photo shows how the Great Basin wildrye understory has thickened and spread nine months after the rabbitbrush competition was removed. 6-563-9 S.C.S. PHOTO

Structural Measures for Flood Prevention and Erosion Control

Water originating in the Santa Rosa Mountains causes the most frequent flooding. These mountains are steep (25 to 60 percent) and any effective structural measures designed to detain the water at its source would not be practical. The least costly flood protection might be to divert excessive flows on the alluvial soils with a system of diversion ditches and pits. This type of protection would decrease damage to crop lands and at the same time recharge the valley groundwater. A diversion would have to be designed that would allow normal flows to pass to satisfy irrigation needs, and divert only excess water.

Generally, the topography of the lands in this sub-basin is too steep for practical and effective sediment and erosion control structures. Vegetal treatment in the source areas would probably be the best answer to these problems. Because of sparse cover on most of the range land, considerable sheet erosion occurs.

Channel and gully erosion control is needed in the valley bottoms to protect the existing meadows and restore desiccated meadow lands. Permanent type control structures placed at selected sites are considered the most economical treatment. In conjunction with structural measures, bank sloping and seeding will help prevent channel bank cutting and stream meandering.

Possibilities for Water Salvage

There are approximately 71,500 acres of various types of phreatophytic plants in the sub-basin using approximately 42,700 acre-feet of water annually. Included are 11,400 acres of creeping wildrye, 8,100 acres of Great Basin wildrye, 8,400 acres of alkali sacaton, and 2,500 acres of alfalfa, which are the plant species used for hay and pasture in the sub-basin. The remaining 41,100 acres are non-beneficial phreatophytic growth.

Loeltz et al. made the assumption that if the water table were lowered in Paradise Valley about 20 feet by pumping for irrigation, the underflow to the Humboldt River would be practically eliminated. This would help to eliminate undesirable phreatophyte growth and thereby make more water available for pump irrigation. The Field Party estimated that the amount of water which could be salvaged for irrigation would be in the range of 15,000 to 20,000 acre-feet annually.

Another procedure would be to remove the woody type phreatophytes on selected sites and allow the wildrye plants to take their place in ground water use. This would not save water but would provide a more beneficial use (see photograph 6).

Forest Service Programs on National Forest Land

Improvement measures needed on national forest lands in the Martin Creek and North Fork Watersheds are included in the discussion of project-type programs for these two watersheds.

The area from Singas Creek southward to the sub-basin boundary is not considered susceptible to project-type solution of watershed problems. However, this part of the sub-basin includes 9,310 acres of national forest land upon which watershed conditions can be improved by the following measures.

Land Treatment Measures (Watershed Protection)

1. Adjust Cattle Numbers. - Adjustment of cattle numbers to the indicated safe capacity of grazing allotments on the forest, where such satisfactory adjustment has not already been accomplished. Total closure to livestock use will be needed on some national forest lands, to allow restoration of an adequate vegetal cover for watershed protection, particularly in Singas Creek and probably the canyons southward from there. These canyons are steep and rough. Also, at present most of the lower slopes and the high basins at the canyon heads have an inadequate vegetal cover. Some soil movement has already taken place in the drainage heads south of Solid Silver Creek. Elimination of domestic livestock use will facilitate the natural revegetation of these overused areas suitable for such use.

2. Control Deer Numbers. - During the summer months, the Santa Rosa Range is one of the few islands of green vegetation for many hundreds of square miles. Consequently, it has become one of the infrequent places where deer summer range overuse occurs; the deer crowd onto its slopes and basins from the lower expanses of desert and semi-desert. This use is especially heavy in the basins and drainage headwaters of the canyons discussed above.

Most of these canyons on the south end of the Santa Rosas have inadequate roads; this has resulted in light hunting pressure. To correct this, and help eliminate the deer overuse of the high summer ranges through improved hunter access, more improved roads should be constructed, particularly on the south end of the Santa Rosas. Some of the existent roads will have to be completely rebuilt to a higher standard, including adequate erosion-proofing.

Other Federal and State Programs

Bureau of Land Management Programs on National Land Reserve

Highlights of the Bureau of Land Management's range management program include the protection, proper use and improvement of the national land reserve. Grazing adjudication, a phase of the range management work, includes (1) a review and study of the base property and development of records for each grazing user, (2) an up-to-date range forage inventory, and (3) adjustment of the stocking rate to current available forage information. The program also envisions defined seasonal areas of use, range administration, and developing range improvements necessary to obtain proper distribution of livestock and more uniform and proper use of forage.

The soil and moisture program is integrated with the grazing program and consists of stabilization and rehabilitation projects necessary to conserve soil, water, and closely-related resources. The work also includes improvement of vegetation through natural revegetation, control of undesirable forage plants, and the reseeding of more desirable plants. The weed control program on the national land reserve is designed to arrest the invasion of new weed species which are poisonous or mechanically injurious to domestic livestock or threaten the agricultural economy of the area.

Deer summer forage problems on the national land reserve in the sub-basin, because of generally lower elevations, are not as extensive as on the national forest. The lower areas are very important as a deer winter range, with localized areas of heavy use. A majority of big game animals must winter on the national land reserve and scattered privately owned range areas available to them. The Bureau of Land Management program provides for reserving sufficient forage to provide for a reasonable number of big game.

Cooperative State and Federal Programs

Big Game Management

The Nevada State Fish and Game Commission, in cooperation with the Forest Service and the Bureau of Land Management, has within the past few years developed a management formula for deer harvest in Area 5, which covers the Santa Rosa Mountains and adjacent areas.

Fire Prevention and Control

Present fire prevention plans, and plans to meet future fire protection needs, have been prepared by the U. S. Bureau of Land Management, State of Nevada (Division of Forestry), and the U. S. Forest Service.

WATERSHEDS WITH OPPORTUNITIES FOR PROJECT-TYPE DELVELOPMENT

The Watershed Protection and Flood Prevention Act (Public Law 566, 83d Congress, as amended) authorizes the Secretary of Agriculture to give technical and financial help to local organizations in planning and carrying out watershed or subwatershed areas of 250,000 acres or less. These projects are for: (1) flood prevention; (2) the agricultural phases of water management; and (3) other purposes, such as municipal and industrial water supplies, and water improvement for fish and wildlife. Project works of improvement include land treatment measures and structures having not more than 5,000 acre-feet of floodwater detention capacity, or not more than 25,000 acre-feet of capacity for all purposes.

Watershed projects provide a means for coordinated scheduling of needed improvements on public and private lands which would only otherwise be accomplished over a longer period of time under regular public land programs.

The problems in at least three watersheds in this sub-basin - Martin Creek, North Fork, and South Fork -are such that they can best be handled on a project basis. Projects in each of these watersheds would provide for watershed protection, supply late irrigation water, reduce frequent flooding, reduce sediment damage, and reduce erosion damage.

For maximum protection to the irrigated lands in Paradise Valley these projects should be developed and installed together; however, the Martin Creek Watershed could be developed separately with satisfactory results.

The North Fork and South Fork Watersheds should be developed as companion projects. Irrigated lands lying south of Sheldon Lane in the south end of Paradise Valley would benefit principally from these two projects.

Martin Creek Watershed

The Martin Creek watershed includes that portion of the Little Humboldt Sub-Basin lying north of Sheldon Lane in Paradise Valley, and from the Hanson (Handy Creek) drainage in the Santa Rosa Range north to the watershed divide between Martin Basin and the North Fork.

A project in this watershed could be developed from one of two different plans. Both plans would require a multiple-purpose reservoir at the Sugarloaf site with capacity for irrigation water, sediment storage, and partial flood protection.

One plan would necessitate the storage of spring runoff from Martin Creek plus the runoff from the smaller drainages on the east slope of the Santa Rosa Mountains, from Hanson Creek to Spring City Creek. This proposal would provide for the installation of a concrete dam about 185 feet high which would hold about 20,000 acre-feet of water for irrigation and flood protection. Other features of the plan are: About four irrigation diversion structures; 25 miles of diversion channel to pick up water from the smaller drainages previously mentioned; 30 miles of irrigation supply ditches; and the necessary headgates and control structures needed for water management.

This plan contemplates that the 80 percent flow would be concentrated on about 4,500 to 5,000 acres of alfalfa and that the remaining bottom land would be cleared of brush and used. for pasture.

The second plan would be similar to the first except that: (1) only Martin Creek water would be stored behind the concrete dam; (2) the dam would be about 175 feet high and store about 12,500 acre-feet of irrigation water and at least 2,000 acre-feet of floodwater; (3) there would be about 20 miles of irrigation supply ditches; and (4) the water would be used on some 3,000 acres of alfalfa.

Deterioration of the watershed and the resulting decrease in forage production is detrimental to the livestock industry. These conditions can be improved by the achievement of a high level annual forage crop production on the watershed and the irrigated lands. Water studies show that land treatment measures on the watershed would have little if any effect on the quantity of water for irrigation, while the quality of water would be improved.

Benefits also could be expected to accrue from the improvement of the high mountain watershed areas, brought about through the application of land treatment and structural measures. As a result of this improvement in watershed conditions, a more uniform water regimen could be anticipated and there would be a substantial lessening of the sediment load.

The reservoir on Martin Creek and the proposed land treatment and structural measures would:

1. Store water for better seasonal irrigation distribution.
2. Reduce flood damage on irrigated land by removing the peaks from spring runoff and from high intensity storms.
3. Allow a more intensified type of farming in the Paradise Valley project area.
4. Reduce sediment damage on irrigated lands.
5. Increase irrigation water efficiency from the present estimated 20 percent to approximately 50 percent.
6. Increase hay and pasture yields by planting better forage crops.
7. Increase the acreage available for pasture by reducing the acreage required to produce hay.

The decision as to whether this watershed should or should not include the Cottonwood water will have to be determined by the local interests, and a more intensive study made of benefits and cost. Benefit-cost estimates indicate that both of these proposed developments are worthy of further study. (See Appendix I, page 47)

North Fork Watershed

North Fork is a tributary to the Little Humboldt River. The drainage is about 36 miles long, with an average width of about seven miles. The area below the mountain slopes is mostly a gently to moderately sloping basaltic plain, with small areas of sharp rimrock relief and a moderately deeply eroded main water course. The boundary of the watershed runs roughly southward from the top of the North Fork drainage to its confluence with the South Fork of the Little Humboldt River.

All but 300 acres of the agricultural benefit area for a project in this watershed would lie outside the watershed boundary. The main problems that were found to be significant concern the seasonal distribution of water, lack of control structures, and efficient use of water.

It is proposed that an earth dam be constructed at the Greeley site that would form a reservoir with an estimated capacity of 12,500 acre-feet, of which 7,500 acre-feet would be used for irrigation and 5,000 acre-feet for floodwater storage. After conveyance losses there would be about 4,800 acre-feet of water available for irrigation in the benefit area. In addition to this structural work it would be necessary to construct diversions, supply ditches with proper controls, and improve about eight miles of stream channel.

The reservoir water would be concentrated on about 1,200 acres of land for hay production. This would allow about 4,500 acres now being cropped for hay to be converted to the production of about 4,500 AUM's of additional pasture.

It is estimated that about 9,500 acres of rabbitbrush, greasewood, and other brush-type plants could be cleared, giving the wildrye understory a chance to spread. Approximately 9,500 AUM's of additional grazing could be obtained by this treatment. Of this total, about 8,000 AUM's would be in the benefit area in conjunction with the South Fork watershed, and about 1500 AUM's would be in the North Fork watershed.

In general the range has a low to medium forage production rate. To improve the range, it would be necessary to fence certain areas, control sagebrush on selected sites, control erosion in some areas, consolidate the Federal land ownership pattern where needed, make some adjustment in cattle and deer numbers, and improve distribution by intensified salting, riding and water development. It is estimated that in 50 years the acreage of fairly high forage production range could be increased nine times and the acreage with low forage production decreased three-fourths.

Preliminary evaluations show that a project in this watershed would have a favorable benefit-cost ratio and therefore justifies further study. This project should be developed as a companion to one on the South Fork Watershed. (See Appendix I, page 61)

South Fork Watershed

The South Fork of Little Humboldt River and Milligan (Dry) Creek drainages comprise most of the eastern extremity of the Little Humboldt Sub-Basin. These watersheds form a roughly rectangular block, with the Owyhee Plateau along its north and east sides, and the Osgood and Snowstorm Mountains as its south boundary.

The main agricultural benefit area for a project in this watershed would be outside the watershed boundary. The problems that were found to be most significant concern the seasonal distribution of water, lack of control structures, and efficiency of water use.

It is proposed that an earth dam be constructed at the Latons Spring site that would be about 970 feet long and 56 feet high. The capacity of the reservoir behind this dam would be about 10,800 acre-feet, which would be used for irrigation and floodwater storage. About 5,800 acre-feet of water would be available for irrigation in the benefit area. In addition to this structural work it would be necessary to construct diversions, supply ditches with proper controls, and do some channel improvement.

The reservoir water would be concentrated on about 1,100 acres of land for hay production. This would allow about 4,000 acres now being cropped for hay to be converted to the production of an additional 4,000 AUM's of pasture.

There are an estimated 10,000 acres of brush-type phreatophytic plants that could be cleared in the project area and benefit area combined. This could give relief to the Federal and private range use by about 10,000 AUM's. Of this total, approximately 8,000 AUM's

would be in the benefit area in conjunction with North Fork watershed, and about 2000 AUM's in the South Fork watershed.

In general the range is mostly in a low to medium forage production class, with resultant adverse effect on the livestock industry. To improve the range it would be necessary to fence the allotments, control sagebrush on selected sites, reseed suitable sites, develop stockwater where needed, and control erosion in some areas. It is estimated that over a 50 year period the acreage of fairly high forage production range could be increased about four times, while the acreage of low forage production would be decreased about 50 percent.

Preliminary evaluations indicate that this watershed would have a favorable benefit-cost ration and therefore justifies further study. This project should be developed as a companion to one in the North Fork watershed. (See Appendix I page 71)

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APPENDIX I

A P P E N D I X   I

Pertinent material of value to the general reader, for reference and guidance in the use of the sub-basin report.

Table of Contents

MARTIN CREEK WATERSHED

Physical Features of the Watershed

Location

The Martin Creek watershed includes that portion of the Little Humboldt Sub-Basin lying north of Sheldon Lane in Paradise Valley, and from the Hanson (Handy Creek) drainage in the Santa Rosa Range north to the watershed divide between Martin Basin and the North Fork.

Water Supply and Use

Surface Water

The Santa Rosa range is the source of water for this project watershed. Runoff from snow furnishes most of the irrigation water. There are 19 maintained stockwater developments in this area; these, along with springs and seeps, furnish water for wildlife and livestock.

Martin Creek and Cottonwood Creek are the only streams that could be referred to as having continuous flow. The discharge extremes of Martin Creek range from 9,000 c.f.s. on January 21, 1943 to 1.8 c.f.s. on February 6, 1945. The gage was removed on Cottonwood Creek in 1951, but the known discharge extremes of this stream range from an estimated high of 1,015 c.f.s. in 1952 to parts of days with no flow at all at Paradise Valley.

The Annual Water Balance study made by the Field Party indicates that the 80 percent frequency flow from Martin Creek would be around 12,500 acre-feet and that the combined drainages north of Hanson Creek would produce around 8,000 acre-feet (above diversions).

The surface water supply is used primarily to irrigate about 11,000 acres of native hay and pasture land and around 700 acres of alfalfa. In addition, a portion of Martin Creek and Cottonwood Creek waters are mixed with water from the Little Humboldt to irrigate lands below Sheldon Lane. The actual number of acres irrigated each year varies with the water supply available for that year.

Ground Water

The ground water developments in the watershed are for domestic and irrigation use. Wells have been drilled in search of irrigation water on the alluvial fans, but the supplies found to date have been inadequate. Present producing irrigation wells are found on the bottom lands of Paradise Valley, but at present only about 50 acres are being irrigated from this source of water.

Recreation Special Use Sites and Areas

Table 17 covers the present recreation special use on the Paradise Valley Ranger District. This water need amounts to around 950 gallons per day for 150 days, for a total of .45 acre-feet. Up to the present time, no additional developments of any of these types of national forest

special uses have been planned. The table, then, represents only present water requirements for all special uses on this Ranger District; it does not take into consideration water requirements for possible future special use developments.

With increased population pressures and improved access, it is expected there will be a concomitant increase in demand for all types of special uses on the national forest. It is anticipated that by the year 2,000 the present water requirements will probably be tripled for this type of national forest use.

At the present time there is but one national forest recreation development, the Martin Creek campground on Road Creek. There is one area outside the national forest, at the mouth of Martin Creek. There is no way of accurately determining the small amount of water needed for this purpose.

Soils and Geology

Elevations range from about 4,400 feet in the bottom hay and meadow lands to 9,779 feet at Granite Peak in the Santa Rosa Range. The Santa Rosas in this area average about 8,000 feet in elevation.

With the exception of Compton's investigations of the Santa Rosa Mountains, little geologic mapping has been done in the mountain ranges surrounding Paradise Valley, but it is believed that the predominant rocks in the Santa Rosa Range are clay slates, calcareous slates and some limestone. These rocks have been intruded by stocks of granodiorite or quartz monzonite and are cut by numerous faults. Generally, the sediments in the northern part of the Santa Rosa Range dip at high angles to the east and are strongly folded and compressed. (See Water Resources Bulletin No. 10, page 25, also Vol. 71, Bulletin of the Geological Society of America, September 1960.)

The soils of the watershed might be described generally, using the Great Soils Groups, as being predominantly Regosols with lesser amounts of Sierozems, Chestnuts, and Lithosols at elevations above 5,000 feet. These soils are mostly moderately deep to deep, stony and gravelly, medium textured, and well drained, with the exception of the Lithosols, which are shallow and coarse textured. The irrigable lands lie below 5,000 feet. In these lands the predominant soils are Humic Gleys and Alluvials, with small acreages of Calcium Carbonate Solonchaks, Sierozems, and Solonetz. This group of soils is deep, well to poorly drained, medium to fine textured, and range in saline-alkali from none to high (see tables 13 and 14). Table 4 gives the acreage of land, broken down by soil associations and phases, of each association.

Vegetation

Vegetal cover on the lower areas is predominantly sagebrush, rabbitbrush, and greasewood, and is sometimes quite tall and thick, but with very little perennial grass present as an understory. The range forage production varies from medium to low, with a limited acreage of fairly high forage production.

The majority of the high country above 6,000 feet consists of sagebrush-bunchgrass cover (Idaho fescue, bluebunch wheatgrass) interspersed with mixed browse and coniferous and aspen timber. Range forage production is predominantly low to medium, with relatively small acreages of fairly high forage production.

Table 4. -- Acreage of land by soil association and soil phase in Martin Creek watershed

Soil association	Percent each phase	Total acres	Soil description
A5-A6-H2	--	4,939	A deep, medium textured bottomland alluvial fan with nearly level slopes, interspersed with moderate to strongly saline and alkali soils, adjacent to the town of Paradise Valley.
A5	60	2,963	
A6	20	988	
H2	20	988	
A7-A2-S1	--	1,356	An alluvial fan with shallow soils underlain by gravels, in the west central side of the valley.
A7	60	814	
A2	20	271	
S1	20	271	
A12-A6-H2	--	6,585	A deep, medium textured, imperfectly drained, alluvial fan and terraced bottomland soil, interspersed with salts and alkali, in the northern end of Paradise Valley.
A12	60	3,952	
A6	20	1,317	
H2	20	1,317	
B1-R1-L1	--	8,053	A shallow to deep, stony and gravelly, medium textured soil, on a steep, mountainous, rolling area at the eastern base of the Santa Rosa Mountains.
B1	60	4,832	
R1	20	1,611	
L1	20	1,610	
B2-A8	--	10,931	A moderately deep to deep, medium textured soil, on gently to strongly sloping alluvial fans northwest of Paradise Valley.
B2	60	6,559	
A8	40	4,372	
B2-P1	--	7,377	A shallow, stony, medium textured Planosol, with moderately deep to deep, medium textured Brown Soil, on moderately to strongly sloping alluvial fans in the lower and central part of Solid Silver and Indian Creeks.
B2	60	4,426	
P1	40	2,951	
C2-R8-P1	--	5,250	A shallow and moderately deep to deep, medium and stony medium textured soil, in an upland basin, with gently rolling, moderate to strong slopes, at the head of Cabin Creek in Martin Basin
C2	60	3,150	
R8	20	1,050	
P1	20	1,050	
H1-H3-A6	--	12,641	A deep, medium to fine textured soil, on the nearly level flood plain area of Paradise Valley. It is imperfectly to poorly drained, and is interspersed with moderately to strongly saline and alkali soils.
H1	50	6,321	
H3	30	3,792	
A6	20	2,528	

Continued

Table 4. -- Acreage of land by soil association and soil phase in Martin Creek watershed - - Continued

Soil association	Percent each phase	Total Acres	Soil description
R1-B1-L1	--	13,926	A moderately steep mountainous area bordering the western portion of the Owyhee Desert. The soils are shallow to deep, stony, medium textured, and are somewhat excessively drained.
R1	50	6,963	
B1	30	4,178	
L1	20	2,785	
R3-L2-C1	--	108,182	A shallow to deep, stony and gravelly, medium to coarse textured soil, covering most of the Martin Creek drainage.
R3	60	64,909	
L2	20	21,637	
C1	20	21,636	
R7-C1-L2	--	5,160	A shallow to deep, stony and gravelly, medium textured soil in the upland mountainous area in the north end of the Martin drainage.
R7	60	3,096	
C1	20	1,032	
L2	20	1,032	
S1-A2	--	4,311	A moderately deep to deep, medium and gravelly medium textured, well drained soil, on an alluvial fan in the northeast portion of Paradise Valley and west of the town of Paradise Valley.
S1	80	3,449	
A2	20	862	
S1-A2	--	435	A moderately deep to deep, medium and gravelly medium textured, well drained soil, on an alluvial fan in the northeast portion of Paradise Valley and west of the town of Paradise Valley.
S1		305	
A2		130	
S6-S5	--	10,070	Shallow to deep, medium to gravelly medium textured soils, on a gently to strongly sloping alluvial fan or terrace northeast of Paradise Valley.
S6	60	6,042	
S5	40	4,028	
S7-R9-L3	--	19,948	Shallow to deep, stony medium to coarse textured soil, on the gently rolling lava plain area within the Martin Creek watershed.
S7		11,969	
R9		5,984	
L3		1,995	
X1-H3-Y1	--	1,389	A deep, moderately fine to fine textured, imperfectly drained flood plain soil, which is slightly to strongly affected by salt and alkali, and located at the mouth of the Little Humboldt River.
X1	60	833	
H3	20	278	
Y1	20	278	

For detailed characteristics of soil phases see table 13, Appendix I.

Source: Humboldt River Basin Field Party.

Land Status

Within the Martin Creek watershed, the land status is as shown below. The private land, totaling 53,800 acres, has 30 owners. There are 19 ranch units operating primarily in the watershed; the remaining land is held by 11 owners and constitutes small range acreages held by ranchers headquartered outside the watershed, land speculators, and as patented mining claims.

Land Status	Acres
National Forest.	78,750
National Land Reserve. . . .	88,000
Private.	53,800
Total.	220,550

Land Use

The irrigated land of the valley is used to produce winter feed for cattle grazing on the national forest and the national land reserve lands. Under present water supply conditions, 11,180 acres of native hay and 760 acres of alfalfa are irrigated. The actual amount of hay and pasture acreage irrigated each year varies with the water supply available.

The national forest lands are used for domestic livestock and wildlife ranges, for recreation, and are the principal water-yielding areas. The national land reserve is used for multiple purposes, grazing by domestic livestock and wildlife being among the major uses.

Climate

The average annual precipitation at the Paradise Valley station is 8.85 inches, based on approximately 40 years of U.S. Weather Bureau records. The average annual temperature is 48.6 °F, based on four years of record. (See figure 1). Most of the moisture falls in the form of snow during the winter months. Except for occasional thunderstorms, the summer rainfall is very light.

The growing season for irrigated crops would depend upon the crop grown, which can be estimated from the freeze data published by the Weather Bureau for Golconda, Winnemucca, and Orovada. These data indicates the growing season for Paradise Valley, based on a 28°F temperature, to be around 140 days.

Watershed Problems

Agricultural Water Management

Irrigation water, generally, is depleted by the end of June in the Martin Creek drainage and before this date in the Cottonwood system of drainages. Residual flow after June is enough in most years for stockwater and additional irrigation for small acreages. There are no storage or regulatory reservoirs in the potential project area. Sugarloaf and Hardscrabble, the only sites suitable for structures of this type, are in the Martin Creek drainage.

Each ranch has one or more diversions and distribution systems. There are only a few ditches that convey water to more than one ranch. The general practice is to maintain a diversion in the creek channel for each field ditch.

The acreage of land irrigated each year is dependent on the water supply available. There have been very few years when all the water rights in the valley were satisfied, except in high runoff periods. The one big problem of the irrigator is to cover as many acres of hayland as possible with the water available. All the native hay and pasture lands are flooded, using a system of gradient spreader ditches. A few alfalfa fields have been leveled and the border method of irrigation applied.

Field irrigation water efficiency is quite low in this valley, as may be expected with high spring runoff and inadequate control structures. It would be difficult to obtain sustantial improvement in this efficiency without a better seasonal distribution of water.

There is some ground water available in the flood plains of the valley, but all attempts to develop irrigation wells on the alluvial fans to date have been unsuccessful.

Agricultural water management problems that were found to be prevalent are:

1. Poor seasonal water distribution.
2. The water supply is used to produce low-yielding forage on large acreages.
3. Lack of adequate water control structures.
4. Low water use efficiency.
5. Sediment and erosion damage need to be reduced.
6. Non-benefitial phreatophytes need to be controlled.

Flood Water Damage

Since 1863, there have been eight major rain-on-snow or snowmelt wet-mantle floods which have caused damage - 1868, 1881, 1890, 1907, 1914, 1938, 1943, and 1952. There have been at least two major dry-mantle floods which have caused damage - the July 1913 and June 1918 floods out of Cottonwood and Mullinix Canyons (see Flood Chronology).

Most of the damage from floods in the Martin Creek-Cottonwood Creek area has been in the form of soil movement and channel cutting from the flashy runoff in the early spring months, primarily in the high basins and upper portions of the Cottonwood-Mullinix-Solid Silver Creek drainages. Also, some channel cutting and silt deposition have occurred in the fields along Cottonwood Creek, above and northeast of the town of Paradise Valley, on the Buckingham Ranch (see photograph 4). Through the town itself, Cottonwood Creek has not escaped its channel except in 1881 and 1938. South of the town the vertically cut banks of the Cottonwood channel and the eroded area directly below the "tight dams" are evidence of channel damage from these past floods, however, the grass and willows now growing in the channel bottom furnish some evidence that this channel cutting may now be somewhat arrested, except perhaps for extremely heavy runoff periods.

The early peaking of stream flows is even more pronounced in years of high water yield and flood years. This early heavy runoff also has an effect on the domestic and culinary water supply in the town of Paradise Valley and the surrounding area. These high waters cause a backing up of water into the domestic wells, filling them with water which tests high in pollutants.

Sheldon Lane and other east-west roads across the valley, south of the town of Paradise Valley, have been badly eroded at times by the combined high waters from Indian and Martin Creeks, and from Cottonwood Creek and its tributaries. Road fills, culverts, and bridges were especially damaged by the 1952 snowmelt runoff.

The damage area from these past floods, above and below the town of Paradise Valley, amounts to approximately 10,000 acres, with an additional 1,000 acres of watershed damaged in the high basins.

These infrequent major floods have inhibited the use of some of the fields east and south of Paradise Valley during the spring and early summer periods because of standing water, silt depositions and mud. The presence of "tight dams" in the area below the town has undoubtedly contributed to some of this inundation of fields and pastures. However, to most water users this is a part of their process if irrigation, and it is not generally recognized or acknowledged as doing damage to their fields.

Sediment Damage

The upper reaches of the streams emanating from the Santa Rosas west and northwest of Paradise Valley (Lamance, Cottonwood, Mullinix, Solid Silver) have been the source of most of the damaging sediment.

Under present conditions the sediment damages on irrigated land are scattered throughout the valley as a result of the diversion and irrigation systems used. Because the damaged areas are spread out, no estimate of acreage was made.

Vegetation - Kind and Condition

Phreatophytes

The phreatophyte acreage is found along the bottom lands of Martin Creek and Cottonwood Creek, mostly south and east of the town of Paradise Valley. The main phreatophyte species are rubber rabbitbrush (Chrysothamnus nauseosus), black greasewood (Sarcobatus vermiculatus), Great Basin wild rye (Elymus cinereus), creeping wildrye (Elymus triticoides), and silver buffaloberry (Shepherdia argentea). These occur in almost pure stands, or as combinations of two or even three or four species together. Quite often the rabbitbrush and buffaloberry are found as a thinly scattered to rather dense overstory in the Great Basin wildrye - creeping wildrye meadow.

North of the town of Paradise Valley, on the lower reaches of Indian Creek and between Indian Creek and Martin Creek, south of the Red Hills, there is a fairly extensive area of rubber rabbitbrush, over three feet in height, intermixed with big sagebrush (Artemesia tridentata) and small amounts of silver buffaloberry.

On Cottonwood Creek northeast of the town are several stringers of willow generally ranging in height from five to eight feet, although quite often reaching heights of twelve to fifteen feet. There is some willow thinly strung along the edges of the Martin Creek channel south and east of the town, where it is generally found in association with rabbitbrush and buffaloberry.

About 4,200 acre-feet of water are used by the brush-type phreatophytes in the valley. (See table 5).

Table 5. -- Phreatophyte acreage and annual ground water use, Martin Creek watershed

Species	Height class	Density	Acreage range types	Acres irrigated hay & meadows	Annual ground water use (feet)	Annual ground water use (acre-feet)
Black greasewood	3'+	.20-.40	2,000	-----	.4	800
Rubber rabbitbrush	3'+	.20-.40	4,000	-----	.4	1,600
Willow	5'-8'	.25-.40	130	-----	2.3	300
Silver buffaloberry	10'-15'	.20-.50	1,000	-----	1.5	1,500
Great Basin wildrye	-----	.20-.50	150	-----	1.0	150
Great Basin wildrye	-----	-------	-----	2,600	.5	1,300
Creeping wildrye	-----	.20-.50	150	-----	1.0	150
Creeping wildrye	-----	------	-----	2,600	.5	1,300
Alkali sacaton	-----	.20-.50	300	-----	.5	150
Alfalfa	-----	------	-----	700	.5	350
Totals			7,730	5,900		7,600

Source: Humboldt River Basin Field Party.

Range Forage Production

Table 6 gives range forage production acreage, present and potential, on the Martin Creek watershed. This information is arranged by vegetal type, site, and soil associations.

In general, the range in medium to fairly high forage production is found on the upper north and east exposures in Martin Basin, and on the upper reaches of Indian, Coleman, and Solid Silver Creeks. There is some medium to fairly high forage production range in upper Paradise Valley on the national land reserve reseeding areas, such as the Buttermilk, Granite, and Singas Projects.

Opportunities for Development

Agricultural Water Management

Structural Measures

A concrete dam is proposed for the Sugarloaf site in the mouth of Martin Creek. The height of the dam could be varied according to the needs of the people in the valley. A diversion channel about 25 miles long could be constructed to collect water from all the smaller drainages north of Lamance Creek and place it behind the dam for storage. If this collection system were installed the dam would need to be about 185 feet high and hold about 20,000 acre-feet of water.

An alternate proposal would be to provide storage for Martin Creek drainage only. The structure for this purpose would be about 175 feet high and would create storage for at least 14,500 acre-feet of water.

A small amount of storage, 2,000 acre-feet, is estimated in both of the above capacities for flood prevention.

The amount of sediment produced from Martin Creek at the present time seems to be moderate. Considering the ultimate effect of the proposed land treatment measures on the watershed, it seems reasonable to assume that the sediment storage requirement would be small.

A revised irrigation distribution system would be needed in the valley. This would include about four stream diversions, 30 miles of supply ditches, and the necessary headgates, drops, turnouts, etc. Using Martin Creek water only, the supply ditches would be about 20 miles long.

Land Treatment Measures

It is proposed that the available surface water for irrigation be concentrated on fields of alfalfa or alfalfa-grass for production of the total hay needs of this area. In order to utilize the seasonal water supply to the best advantage, it would be necessary to level between 2,700 and 4,200 acres of land, together with using the proper length of irrigation runs, and good management practices.

Assuming water storage for an 80 percent frequency flow, it is estimated that there would be enough water to irrigate between 4,500 and 5,000 acres, if Cottonwood and Martin Creek waters were combined. Using only Martin Creek water, about 3,000 acres could be irrigated. These acreage estimates were made using a net consumptive use for alfalfa of 24 inches and an irrigation efficiency of 50 percent.

Table 6. --Acreage classes of present and potential annual forage plant production grouped by soils for each vegetal type and site, Martin Creek Watershed

SOURCE: HUMBOLDT RIVER BASIN FIELD PARTY.

Vegetal type and site	Present annual forage plant production classes(acres)			Potential annual forage plant production classes (acres)			Treatment needed to reach potential
1. Rabbitbrush-greasewood-grass; saline bottom-lands	Rates of forage prod. 1/2/ (pounds per acre)			Rates of forage prod. 1/ 2/ (pounds per acre)			
Soil associations	850-1500	200-600	20-200	850-1500	200-600	20-200	
H1-H3-A6	-------	-------	6,900	1,000	2,900	3,000	Clear brush, reseeding, proper management and stocking
X1-H3-Y1	-------	800	-----	800	------	-----	Clear brush, proper management and stocking
Sub Total		800	6,900	1,800	2,900	3,000	
2. Big sagebrush-grass; upland benches and terraces	Rates of forage prod. 1/2/ (pounds per acre)			Rates of forage prod. 1/2/ (pounds per acre)			
Soil associations	250-600	100-450	20-150	250-600	100-450	20-250	
A7-A2-S1	600	-------	200	800	-------	------	Clear brush, reseeding, proper management and stocking
A12-A6-H2	-------	-------	5,100	2,500	2,600	------	Clear brush, proper management and stocking
B1-R1-L1	-------	500	7,500	1,000	3,000	4,000	Proper management and stocking, fencing
B2-A8	1,100	200	7,000	2,200	2,100	4,000	Clear brush, spraying, reseeding, proper management and stocking
B2-P1	-------	400	7,700	1,000	4,100	3,000	Spraying, proper management and stocking, fencing
S1-A2	-------	-------	4,700	2,400	2,300	-----	Clear brush, reseeding, proper management and stocking, fencing
S6-S5	-------	1,900	8,200	1,000	4,600	4,500	Proper management and stocking, fencing
S7-R9-L3	1,800	7,300	10,700	3,600	10,200	6,000	Spraying, proper management and stocking, fencing
Sub Total	3,500	10,300	51,100	14,500	28,900	21,500	

3. Shadscale-grass; droughty desert upland	Rates of forage prod. 1/ 2/ (pounds per acre)			Rates of forage prod. 1/ 2/ (pounds per acre)			
Soil associations	100-200	50-150	10-50	100-200	50-150	100-200	
A5-A6-H2	-------	------	3,600	1,000	1,600	1,000	Clear brush, reseeding, proper management and stocking
Sub Total			3,600	1,000	1,600	1,000	

4. Big sagebrush-grass; steep south and west slopes	Rates of forage prod. 1/ 2/ (pounds per acre)			Rates of forage prod. 1/ 2/ (pounds per acre)			
Soil associations	200-550	100-350	20-150	200-550	100-350	20-150	
R1-L1-B1	7,100	800	6,000	8,000	2,000	3,900	Spraying 3/, proper management and stocking, fencing
Sub Total	7,100	800	6,000	8,000	2,000	3,900	

5. Browse-aspen-grass; north and east slopes and basins	Rates of forage prod. 1/ 2/ (pounds per acre)			Rates of forage prod. 1/ 2/ (pounds per acre)			
Soil associations	300-650	150-500	50-200	300-650	150-500	50-200	
C2-R8-P1	-------	3,100	2,500	3,000	1,600	1,000	Spraying 3/ 4/, proper management and stocking, fencing
R3-L2-C1	4,500	54,000	49,600	37,000	36,100	35,000	Spraying 3/, proper management and stocking, fencing
R7-C1-L2	-------	3,800	1,900	2,000	2,700	1,000	Spraying 3/4/, proper management and stocking, fencing
Sub Total	4,500	60,900	54,000	42,000	40,400	37,000	
Totals	15,100	72,800	121,600	67,300	75,800	66,400	

1/ THESE FIGURES INDICATE TOTAL ANNUAL FORAGE PRODUCTION, AND WILL BE USED AS A BASIS FOR PLANNING NEEDS ONLY. FORAGE PRODUCTION FIGURES WILL NOT BE USED FOR ASSIGNING RANGE CARRYING CAPACITIES. THESE CARRYING CAPACITIES WILL DEPEND UPON SUCH FACTORS AS SLOPE, SOIL DEPTH, SOIL CHARACTER AND STABILITY, AND THE MANAGEMENT OBJECTIVES OF THE ADMINISTRATIVE AGENCY.

2/ THESE RATES REPRESENT PRODUCTION VARIANCE FROM POOR YEARS TO GOOD YEARS. AT HIGHER ELEVATIONS WITHIN THE SITE, WITH GREATER PRECIPITATION THE RATES WOULD BE HIGHER, AND CONVERSELY FOR LOWER ELEVATIONS.

3/ DOES NOT INCLUDE LOCALIZED RABBITBRUSH AREAS.

4/ INCLUDES LOCALIZED DECADENT RANGES NOW PREDOMINANTLY SAGEBRUSH.

Watershed Protection

The following minimum treatment measures are considered necessary to promote watershed protection.

Land Treatment Measures

1. Consolidate the Humboldt National Forest ownership pattern in Martin Basin by a comprehensive land exchange or purchase program for the privately owned lands there.
2. Adjust cattle numbers to the safe carrying capacity of the range.
3. Bring the Santa Rosa deer herd numbers into line with the available food supply.
4. Improve cattle distribution by the following:
   (a) Fence the entire Martin Basin on the national forest, subdivide into pasture units, and institute a deferred-rotation plan of grazing. An estimated total of 78,000 acres would be involved.
   (b) Construct eleven miles of allotment boundary fence on the Buttermilk cattle allotment, on the national forest. Approximately 25,000 acres would be involved.
5. Control sagebrush to reduce competition and improve the watershed grasses and forb cover condition on the Martin Basin and Buttermilk cattle allotments. Approximately 19,000 acres on the Martin Basin allotment and the Buttermilk allotment can be sprayed from aircraft.
6. Reseed all suitable sites having medium and low forage production rates.

Structural Measures

1. As a management measure fence the steep damaged slopes of Buckskin Mountain at the head of Cottonwood Creek, on the national forest.
2. Install bleeder-type gully plugs on the lower ends of Cottonwood Creek and Buttermilk Creek, on the gentler gradients of those streams.
3. Install sloping, reseeding, and other stream channel stabilization measures where applicable along Cottonwood and Buttermilk Creeks.
4. Treat all roads contemplated, in use, or abandoned, to prevent or stop erosion. New road construction should be to a high standard, to insure proper gradients and the installation of necessary erosion-proofing measures.
5. Continue the Bureau of Land Management's program of stockwater development.
6. Continue the fencing of allotments in connection with the Bureau of Land Management's range adjudication program.

Flood Prevention

Flood prevention measures for cultivated land were described under Agricultural Water Management,—Structural Measures.

Vegetal Manipulation

Approximately 5,000 acres of phreatopytic rabbitbrush, buffaloberry, and greasewood should be cleared on sites which at present have an understory of Great Basin wildrye or creeping wildrye.

Benefits Expected

Agricultural Water Management

The proposed irrigation structures would provide a full irrigation water supply 80 percent of the years for about 5,000 acres under a Cottonwood-Martin Creek plan, or about 3,000 acres under a Martin Creek plan. This water should be available for use during the higher consumptive use periods of June, July, August, and September, which at present have no surface water for irrigation during these months. This would allow a more stable irrigation cropping program to be developed. Water in excess of reservoir capacity would be available for the irrigation of pasture land.

Land to be irrigated would not be in a solid block, since adequate water is not available for all the irrigable acreage. Each owner would irrigate only his better and more easily accessible land, where the highest returns could be realized.

By reducing the irrigated acreage needed for hay production the bottom land pasture acreage would be increased, and thereby relieve the pressure on the Federal and private range by an estimated 11,000 AUM's. In addition, (1) a higher quality hay would be grown for stock feed; (2) greater yields would be obtained; and (3) higher irrigation efficiency and partial flood and sediment control would be possible.

Watershed Protection

The benefits to be realized, in terms of range forage improvement, by restoration of the forage loss now being incurred because of soil erosion and watershed cover deterioration are shown in table 6. The improved range condition would also reduce or eliminate soil erosion and the resultant sedimentation.

Flood Prevention

The proposed dam and diversion channel would partially eliminate the smaller, more frequent flooding of the hay fields and pastures.

Vegetal Manipulation

Much of the land covered by phreatophytes east and south of the town of Paradise Valley can be benefited by removing extensive acreages of phreatophytes. The brush phreatophyte forms would be replaced with beneficial grass phreatophytes with high nutritive value. Approximately 5,000 acres can be benefited by eliminating this brush, which would add an estimated 5,000 AUM's of grazing.

Public Health

The pollution of water in the wells around Paradise Valley, caused by the ground water back-up in the spring and early summer, would be reduced by the proposed diversion and storage.

Conclusions

Deterioration of the watershed and the resulting decrease in forage production are detrimental to the livestock industry. These conditions can be improved by the achievement of a high level forage crop production on the watershed and on the irrigated lands. Water studies show that land treatment measures on the watershed would have little if any effect on the quantity of water for irrigation, while the quality of water would be improved.

Benefits also could be expected to accrue from the improvement of the high mountain watershed areas, brought about through the application of land treatment and structural measures. As a result of this improvement in watershed conditions, a more uniform water regimen could be anticipated and there would be a lessening of the sediment load.

The reservoir on Martin Creek and the proposed land treatment and structural measures would:

1. Store water for better seasonal irrigation distribution.
2. Reduce flood damage on irrigated land by removing the peaks from spring runoff and from high intensity storms.
3. Allow a more intensified type of farming in the Paradise Valley project area.
4. Reduce sediment damage on irrigated lands.
5. Increase irrigation water efficiency from the present estimated 20 percent to approximately 50 percent.
6. Increase hay and pasture yields.
7. Increase the acreage available for pasture by reducing the acreage needed to produce hay.

The decision as to whether this watershed should or should not include the Cottonwood water will have to be determined by the local interests, and a more intensive study made of benefits and cost. The estimates made in this study indicate that a project would be favorable under both plans.

NORTH FORK WATERSHED

Physical Features of the Watershed

North Fork is a tributary to the Little Humboldt River. The drainage is about 36 miles long, with an average width of about seven miles. The area below the mountain slopes is mostly a gently to moderately sloping basaltic plain, with small areas of sharp rimrock relief and a moderately deeply eroded main water course. The boundary of the watershed runs roughly southward from the top of the North Fork drainage to its confluence with the South Fork of the Little Humboldt River.

Elevations for the North Fork drainage range from about 4,580 feet in the bottom hay and meadow lands at the confluence with the South Fork to 8,778 feet on Buckskin Mountain.

Water Supply and Use

The Santa Rosa Mountains are the main source of water for this drainage. With an 80 percent flow, the water is largely snowmelt. Such a flow, as determined by water balance studies, would amount to about 8,500 acre-feet for the watershed.

The water from this drainage, mixed with the waters from Milligan Creek and South Fork, is used to irrigate the bottom lands along the Little Humboldt River and the lands below Sheldon Lane in Paradise Valley. There are 15 maintained stockwater developments in addition to the springs and seeps which are used to furnish water for livestock and wildlife. At the present time there are no developed campground or special use water systems in the watershed.

There has been some ground water development in the benefit area for domestic and irrigation use; these wells are in the bottom flood plains of the valley. There are about 14 drilled irrigation wells at the present time, with approximately 10 of these in operation. The estimated rate of flow ranges from about 1,000 g.p.m. (gallons per minute) to 2,700 g.p.m. This water is used to irrigate alfalfa in the valley.

Soils and Vegetation

The soils in this watershed are, for the most part, moderately deep to deep, stony and gravelly, well drained to excessively drained, and medium textured. Included also are areas of shallow, coarse textured Lithosol soils in the mountainous uplands, and small areas of deep, fine textured, poorly drained Humic Gley soils in the bottomlands. (See table 7).

Within this watershed the land is mostly used for the production of range forage. The vegetal cover has a general sagebrush aspect, with scattered patches of mixed browse and aspen at the higher elevations. Bluebunch wheatgrass, mountain brome, Idaho fescue, squirreltail, and Sandberg bluegrass are found in these higher areas, growing as an understory to the browse and aspen cover, in varying degrees of density. Extensive areas of cheatgrass form an understory to the sagebrush aspect on many of the lower slopes.

Land Status and Use

The land ownership acreage is as shown below:

Land Status	Acres
National Forest	42,500
National Land Reserve	98,700
Private	9,800
Total	151,000

Federal lands are used for range and as a water-producing area. There is no commercial forest land, nor is there at present any acreage reserved specifically for recreational use.

There are extensive unpatented mine workings on the east side of Buckskin Mountain. Because of the inactive status of these claims, currently there is no conflict with other national forest uses.

Climate

Most of the moisture falls in the form of snow during the winter months. Except for occasional thunder storms, the summer rainfall is very light. There are no temperature records for the area. The closest precipitation record station is at Paradise Valley with a 40 year record. There are storage gages on Buckskin Mountain (13 year record) and on Hinkey Summit (five year record). The Hinkey Summit gage was supplemented by other gages at Ruck's Cabin and Indian Creek in 1959. The Buckskin Mountain records indicate an average precipitation for that station of 25 inches.

Watershed Problems

Agricultural Water Management

The main agricultural benefit area for this watershed is outside the watershed boundary. The area consists of a proportional part, shared with the South Fork watershed, of the bottomlands along the Little Humboldt River and the irrigated land in Paradise Valley below Sheldon Lane. There also are about 300 acres of bottomland along the lower (south) end of the North Fork, within this watershed boundary.

Normally the available water is inadequate to irrigate all of the irrigable land. There have been very few years of high runoff when all the water rights were satisfied. There are no storage or regulatory reservoirs in the project area.

Fields are irrigated by a system of flooding between gradient ditches. The land surface is uneven, which makes it difficult to obtain uniform irrigation and efficient water use. Water becomes available during the spring runoff only, which makes it necessary that the water be spread over as many acres as possible during this period of flow.

Agricultural water management problems that were found to be prevalent are:

1. Poor seasonal water distribution.
2. The water supply is used to produce low yielding forage on large acreages.
3. Lack of adequate water control structures.
4. Low water use efficiency.
5. Sediment and erosion damage need to be reduced.
6. High water table on some of the flood plain land.
7. Non-benefitial phreatophytes need to be controlled.

Table 7. --Acreage of land by soil association and soil phase in North Fork watershed

Soil association	Percent each phase	Total acres	Soil description
C2-A11	--	21,300	A moderately deep to deep, medium textured soil, on gently to moderately sloping mountain slopes and lava plains. This is an upland area in the northern end of the North Fork of the Little Humboldt River.
C2	90	19,200	
A11	10	2,100	
H4-A4	--	2,900	A deep, medium textured, imperfectly to poorly drained soil, on the flood plain of the North Fork.
H4	80	2,300	
A4	20	600	
R1-B1-L1	--	20,600	A moderately steep mountainous area bordering the western portion of the Owyhee Desert. The soils are shallow to deep, stony, medium textured, and are somewhat excessively drained.
R1	50	10,300	
B1	30	6,200	
L1	20	4,100	
R3-L2-C1	--	29,400	A shallow to deep, stony and gravelly, medium to coarse textured soil, in the north central part of the drainage.
R3	60	17,600	
L2	20	5,900	
C1	20	5,900	
R7-C1-L2	--	16,700	A shallow to deep, stony and gravelly, medium textured soil in the upland mountainous area in the north end of the North Fork watershed.
R7	60	10,100	
C1	20	3,300	
L2	20	3,300	
S6-S5	--	2,800	Shallow to deep, medium to gravelly medium textured soils, on a gently to strongly sloping alluvial fan or terrace northeast of Paradise Valley.
S6	60	1,700	
S5	40	1,100	
S7-R9-L3	--	57,300	Shallow to deep, stony medium to coarse textured soil, on the gently rolling lava plain area, in the central and south end of the North Fork watershed.
S7	60	34,400	
R9	30	17,200	
L3	10	5,700	

For detailed characteristics of soil phases see tables 13 and 14.

Source: Humboldt River Basin Field Party.

Floodwater Damage

There have been eight major wet-mantle floods since 1863 which have caused damage - 1868, 1881, 1890, 1907, 1910, 1914, 1943, and 1952. These floods have caused varying degrees of erosion, sediment deposition, and inundation. (See Chronology of Flood Years).

Erosion Damage

Erosion damage occurs in the form of channel cutting along the main stream of the North Fork and the Little Humboldt River. Along the North Fork this is particularly apparent above Goosey Lake Flat and from there downstream, where the channel has been cut to depths of ten to fifteen feet. The cutting along the Little Humboldt River channel, from three to eight feet deep, as well as that along North Fork, has resulted in the drainage of meadow areas. The meadow vegetation has been replaced by sagebrush, rabbitbrush, and greasewood.

Vegetation - Kind and Condition

Phreatophytes

The phreatophytes consist mainly of willows in and along the channel of North Fork and small acreages of rabbitbrush and wildrye in the bottomlands. In the benefit area the willows are along the channel of the Little Humboldt River, and scattered throughout the hay meadows. Also, in the benefit area below Sheldon Lane, are large acreages of greasewood and rabbitbrush along the outside edges of the meadows. Great Basin wildrye and creeping wildrye grow in the meadows, and in the valley above Gumboot Lake are extensive areas of saltgrass and alkali sacaton. (See table 8).

Range Forage Production

Table 9 shows the acreage breakdown by range forage production class, present and potential, by vegetal type, site, and soil association. In general, the range forage production is mostly low to medium, with small acreages of fairly high forage production in the higher elevations. The Goosey Lake Flat reseeded area also has a fairly high rate of production.

Opportunities for Development

Agricultural Water Management

Structural Measures

It is proposed that an earth dam about 675 feet long and 56 feet high be constructed at the Greeley Flat dam site. The reservoir behind this dam would have a capacity of about 12,500 acre-feet, allowing 7,500 acre-feet for irrigation and 5,000 acre-feet for flood prevention. The dam site is about 36 miles upstream from the irrigated land in Paradise Valley and about 24 miles above the confluence of the North and South Forks. The water losses between the reservoir and the point of use in the valley would reduce the amount of available surface flow for irrigation to an estimated 4,800 acre-feet. The benefit

Table 8. -- Phreatophyte acreage and annual ground water use, North Fork Watershed

Species	Height class	Density	Acreage range types 1/	Acres 1/ irrigated hay & meadows	Annual ground water use 1/ (feet)	(acre-feet)
Black greasewood	0'-3'	.12-.20	15,300	----	.25	3,800
	3'+	.20-.40	400	----	.40	150
Rubber rabbitbrush	3'+	.20-.40	1,100	----	.40	450
Willow	5'-8'	.25-.40	2,750	----	2.30	6,300
Saltgrass	----	.20-.30	11,200	----	.50	5,600
Great Basin wildrye	----	.20-.50	2,950	----	1.00	2,950
Great Basin wildrye	----	-------	------	2,400	.50	1,200
Creeping wildrye	----	.20-.50	6,000	----	1.00	6,000
Creeping wildrye	----	-------	------	2,500	.50	1,250
Alkali sacaton	----	.20-.50	8,100	----	.50	4,050
Alfalfa	----	-------	------	1,850	.50	900
Totals			47,800 1/	6,750 1/		32,650 1/

1/ The benefit area below Sheldon Lane in Paradise Valley and the Little Humboldt River below the confluence of the North and South Forks are included in these values.

Source: Humboldt River Basin Field Party.

Table 9. --Acreage classes of present and potential annual forage plant production, grouped by soils for each vegetal type and site, North Fork watershed

Vegetal type and site	Present annual forage plant production classes (acres)			Potential annual forage plant production classes (acres)			Treatment needed to reach potential
1. Rabbitbrush-greasewood-grass; saline bottomlands	Rates of forage prod. 1/2/ (pounds per acre)			Rates of forage prod. 1/2/ (pounds per acre)			
Soil associations	850-1500	200-600	20-200	850-1500	200-600	20-200	
H4-A4	--------	-------	2,600	1,600	1,000	------	Clear brush, reseeding, proper management and stocking
Sub Total			2,600	1,600	1,000		
2. Big sagebrush-grass; upland benches and terraces	Rates of forage prod. 1/2/ (pounds per acre)			Rates of forage prod. 1/2/ (pounds per acre)			
Soil associations	250-600	100-450	20-150	250-600	100-450	20-150	
C2-A11	1,000	11,500	8,800	12,300	9,000	------	Spraying, proper management and stocking, fencing, meadow restoration
S6-S5	-------	1,300	1,500	1,300	1,000	500	Spraying, proper management and stocking, fencing
S7-R9-L3	400	5,400	51,500	10,000	37,300	10,000	Clear brush, reseeding, proper management and stocking, fencing
Sub Total	1,400	18,200	61,800	23,600	47,300	10,500	
3. Big sagebrush-grass; steep south and west slopes	Rates of forage prod. 1/2/ (pounds per acre)			Rates of forage prod. 1/2/ (pounds per acre)			
Soil associations	200-550	100-250	20-150	200-550	100-250	20-150	
R1-L1-B1	1,300	-------	19,300	5,000	10,000	5,600	Spraying 3/, proper management and stocking, fencing
Sub Total	1,300		19,300	5,000	10,000	5,600	

Continued

Table 9. -- Acreage classes of present and potential annual forage plant production, grouped by soils for each vegetal type and site, North Fork watershed -- Continued

Vegetal type and site	Present annual forage plant production classes (acres)			Potential annual forage plant production classes (acres)			Treatment needed to reach potential
4. Browse-aspen-grass; north and east slopes and basins	Rates of forage prod. 1/2/ (pounds per acre)			Rates of forage prod. 1/2/ (pounds per acre)			
Soil associations	300-650	150-500	50-200	300-650	150-500	50-200	
R3-L2-C1	2,500	13,700	13,200	12,000	11,400	6,000	Spraying 3/4/, proper management and stocking, fencing
R7-C1-L2	------	14,800	1,900	7,000	8,700	1,000	Spraying 3/4/, proper management and stocking, fencing, meadow restoration
Sub Total	2,500	28,500	15,100	19,000	20,100	7,000	
Totals	5,200	46,700	98,800	49,200	78,400	23,100	

1/ These figures indicate total annual forage production, and will be used as a basis for planning needs only. Forage production figures will not be used for assigning range carrying capacities. These carrying capacities will depend upon such factors as slope, soil depth, soil character and stability, and the management objectives of the administrative agency.

2/ These rates represent production variance from poor years to good years. At higher elevations within the site, with greater precipitation the rates would be higher, and conversely for lower elevations.

3/ Does not include localized rabbitbrush areas.

4/ Includes localized decadent ranges now predominantly sagebrush.

Source: Humboldt River Basin Field Party.

area would need some structural work to make the best possible use of this water. These measures are of mutual concern to both the North Fork and South Fork watersheds. It is estimated that about five diversions, 40 miles of supply ditch, and the necessary headgates, turnouts and drops would be needed. About eight miles of river channel improvement would also be needed in the benefit area.

Land Treatment Measures

For better utilization of the reservoir water it would be necessary that the water be concentrated on a relatively small acreage growing higher-yielding forage crops.

Available runoff water, at least 80 percent of the years, would be enough to irrigate an estimated 1200 acres. Of these, about 900 acres would need to be land leveled.

The lands to be irrigated would not be in a solid block. Each land owner would select his best and more accessible land for cultivation. New irrigation water distribution systems would have to be established.

Watershed Protection

The following measures are considered to be the minimum treatment necessary to promote watershed protection.

1. Consolidate the national forest ownership pattern along the Upper North Fork by a comprehensive land exchange and purchase program.
2. Adjust cattle numbers to an indicated safe carrying capacity.
3. Maintain deer numbers in balance with their food supply.
4. Subdivide certain upper North Fork areas into pastures for deferred-rotation grazing.
5. Close the steep slopes of Buckskin Mountain to cattle use.
6. Control sagebrush on selected sites.

Structural Measures

1. Fence the steep damaged slopes of Buckskin Mountain at the head of North Fork, thus closing the area to cattle use.
2. Fence the upper end of the North Fork in conjunction with the fencing in the Martin Basin watershed.
3. Install bank sloping and bank seeding, in conjunction with stabilization structures, in the eroded channels.

Flood Prevention

The flood prevention measures are discussed under Agricultural Water Management,— Structural Measures.

Vegetal Manipulation

There are about 1,500 acres of phreatophytes inside the project boundaries and about 8,000 acres in the benefit area which can be cleared. The clearing in the benefit area would be in conjunction with the South Fork watershed.

Drainage

There are about 19,000 acres in Paradise Valley, now in salt grass and alkali sacaton, which can be drained by pumping. The soils should be leached to remove salts, and properly conditioned before planting to better forage. The ground water is of such quality that it can be used for irrigation.

Benefits Expected

Agricultural Water Management

The proposed irrigation structures would provide irrigation water for about 1,200 acres of land, 80 percent of the years. This water would be available during the late spring and summer months which at present have no surface water for irrigation during these periods. A more stable irrigation cropping program could then be developed. Water in excess of reservoir capacity would be available for the irrigation of pasture land.

By reducing the irrigated acreage, the bottomland pastures could be increased by about 4,500 acres, thereby relieving Federal and private range use by an estimated 4,500 AUM's.

The benefits expected on irrigated lands would be as follows:

1. Better seasonal distribution of irrigation water.
2. Higher irrigation efficiency.
3. Partial flood control.
4. Production of higher quality hay, with higher yields.
5. More efficient use of labor.

Watershed Protection

The land treatment and structural measures would result in improved range condition and reduced erosion. These benefits are reflected in terms of range forage improvement in table 9. It is estimated that in 50 years the acreage of fairly high forage production range could be increased nine times and the low forage production acreage decreased three-fourths.

Flood Prevention

The reservoir proposed under Agricultural Water Management would give partial relief to the cultivated areas from flood waters originating in this drainage.

Because the Greeley Flat dam would be located about 24 miles above the confluence of North and South Fork, it is not expected that any relief from sediment deposition could be expected.

Vegetal Manipulation

It is estimated that about 9,500 acres of rabbitbrush, greasewood, and other brush-type plants could be cleared, giving the wildrye understory a chance to spread. Approximately 9,500 AUM's of additional grazing could be obtained by this treatment. Of this total, about 8,000 AUM's would be in conjunction with the South Fork watershed in the benefit area, and 1,500 AUM's would be in the North Fork watershed.

Conclusions

The land treatment and structural measures would increase forage production and reduce soil erosion. Within a period of 50 years the acreage of fairly high forage production range could be increased about nine-fold, while the low forage production acreage might be reduced by three-fourths.

An estimated 9,500 AUM's of additional grazing could be obtained by clearing the browse-type phreatophytes on selected sites. This additional grazing would provide needed relief on the Federal and private range.

A reservoir at the Greeley Flat site would furnish storage for about 7,500 acre-feet of irrigation water and 5,000 acre-feet of floodwater. Water losses between the dam and Paradise Valley would reduce the amount of available surface flow for irrigation in the valley to an estimated 4,800 acre-feet. By concentrating the irrigation water on an estimated 1,200 acres of high quality hay, about 4,500 acres could be used to produce about 4,500 AUM's of additional pasture. All but 300 acres of the agricultural land receiving benefits from a project in this watershed would lie outside the watershed boundaries.

This watershed should be developed as a companion to one in the South Fork watershed because of its significance as a watershed area for the irrigated lands in Paradise Valley, and because the waters from North Fork and South Fork are combined prior to extensive use.

SOUTH FORK WATERSHED

Physical Features of the Watershed

South Fork of the Little Humboldt River and the Milligan (Dry) Creek drainages comprise most of the eastern extremity of the Little Humboldt Sub-Basin. These watersheds form a roughly rectangular block, with the Owyhee Plateau along its north and east sides, and the Osgood and Snowstorm Mountains as its south boundary.

South Fork and Milligan Creek come together in a rather deep valley at the South Fork Ranch. South Fork watershed above this junction is about 19 miles long and seven miles wide, with the stream itself flowing through a relatively narrow, deep defile. Below itsconfluence with Milligan Creek South Fork flows for approximately 10 miles, through a valley which becomes gradually wider and shallower, to its junction with the North Fork to form the Little Humboldt River.

Milligan Creek, from the source at the east end of the Snowstorms and the Owyhee Plateau, at first flows northward across the plateau in a gradually deepening trench in the lava rimrock of the plateau, then turns abruptly southwest at the northeast angle of the sub-basin for about 10 miles, and drops down to its junction with the South Fork at the South Fork Ranch. The stream is ephemeral, at least in its upper reaches. Milligan Creek drainage is approximately 35 miles long, and about 10 miles wide at its headwaters, where it is separated from the South Fork by a low, at times almost imperceptible, ridge in the Owyhee Plateau.

Water Supply and Use

The water source for South Fork and most of Milligan Creek is the Snowstorm Mountains, which is the local name for an eastward extension of the Osgood Range. Water studies indicate that South Fork is an important source of water for the Little Humboldt River. Milligan Creek, on the other hand, except for high water years, contributes less than 10 percent to the stream flow regimen of the Little Humboldt. These two streams have an estimated 80 percent frequency flow of about 5,800 acre-feet.

The surface stream flow from this watershed, together with that from North Fork, is used to irrigate native hay and pasture in Paradise Valley, from above Gumboot Lake to about Sheldon Lane, and also along the Little Humboldt River, below North Fork. It also irrigates lands along South Fork below the Latons Spring dam site.

Soils and Vegetation

The soils, for the most part, are moderately deep to deep, stony and gravelly, well drained to excessively drained, and medium textured. Included also are areas of shallow, coarse textured Lithosol soils in the mountainous uplands, and areas of deep, fine textured, poorly drained Humic Gley soils in the bottom lands. The predominant Great Soil Groups consist of Chestnuts, Regosols, Sierozems, and Brown soils, which appear in varying phases throughout the area.

The vegetation varies from sparse to heavy stands of sagebrush on the lower slopes, with an understory of extensive cheatgrass acreage and scattered Sandberg bluegrass, to a mixed

browse overstory with scattered aspen groves on the higher north exposures of the Snowstorms. At these higher elevations, which have been less heavily used by livestock, the cheatgrass and bluegrass understory gives way to a more dense cover of bluebunch wheatgrass, with an admixture of Idaho fescue and some Sandberg bluegrass and squirreltail (Sitanion).

The land is currently used for the production of range forage, and is a water source area, except for 550 acres of irrigated land.

Land Status and Use

Within the watershed, the land ownership acreage is as shown below.

Land Status	Acres
National Forest	0
National Land Reserve	259,200
Private	20,600
Total	279,800

The 20,600 acres of private land in the watershed are held primarily by two owners, and are used essentially for range purposes. There is only one complete ranch unit within the watershed. The remaining private lands are owned by ranch units headquartered outside the Little Humboldt Sub-Basin. The national land reserve produces forage for livestock and wildlife. It has potential value for recreation and other uses. At the high elevations, the national land reserve and private lands in the Snowstorm Mountains are the principal water producers for South Fork.

Climate

Most of the moisture falls in the form of snow during the winter months; except for occasional thunder storms, summer precipitation is very light.

To date there are no precipitation gages on the water producing areas of Milligan Creek or South Fork. The vegetation and soil development show that the precipitation on the mountain slopes and upland areas of the Snowstorms and on the Owyhee Plateau would be less than for comparable zones on North Fork. Although the maximum elevation of the Snowstorm Mountains is around 8,000 feet, they may be in a "precipitation shadow" of the Santa Rosa uplift.

Table 10 -- Acreage of land by soil association and soil phase in South Fork watershed

Soil association	Percent each phase	Total acres	Soil description
B3-P1-C1-L2	--	146,800	Shallow to deep, stony, medium textured soil on mountainous upland and lava plain area in the extreme east side of the sub-basin.
B2	40	58,700	
P1	30	44,000	
C1	20	29,400	
L2	10	14,700	
H4-A4	--	3,300	A deep, medium textured, imperfectly to poorly drained soil, on the flood plain of North Fork.
H4	80	2,700	
A4	20	600	
R1-B1-L1	--	86,400	A moderately steep mountainous area bordering the western portion of the Owyhee Desert. The soils are shallow to deep, stony, medium textured, and are somewhat excessively drained.
R1	50	43,200	
B1	30	25,900	
L1	20	17,300	
S7-R9-L3	--	43,300	Shallow to deep, stony medium to coarse textured soil, on the gently rolling lava plain area within the central and south end of the North Fork watershed.
S7	60	26,000	
R9	30	13,000	
L3	10	4,300	

For detailed characteristics of soil phases see tables 13 and 14, Appendix I.

Source: Humboldt River Basin Field Party.

Agricultural Water Management

The main agricultural benefit area is outside the watershed boundary. It is a proportionate part, shared with the North Fork watershed, of the bottomlands along the Little Humboldt River below the North Fork-South Fork confluence, and the irrigated land in Paradise Valley between Sheldon Lane and the upper margins of Gumboot Lake. In addition to this shared benefit area, the irrigated lands along South Fork between the Latons Spring site and North Fork would be a benefit area directly dependent on this watershed.

All of the irrigable land is watered only during years of high runoff. The number of acres irrigated each year depends on the available surface water. There are no storage or regulatory reservoirs in the project area. Irrigation is done by a system of flooding between gradient ditches. A uniform distribution of water over the fields is difficult because the land surface is uneven.

Agricultural water management problems that were found to be prevalent are:

1. Poor seasonal water distribution.
2. The water supply is used to produce low-yielding forage on large acreages.
3. Lack of adequate water control structures.
4. Low water use efficiency.
5. Sediment and erosion damage need to be reduced.
6. High water table on some of the flood plain land.
7. Non-beneficial phreatophytes need to be controlled.

Floodwater Damage

Since the late 1860's, there have been eight major wet-mantle floods which have caused floodwater damage - 1868, 1881, 1890, 1907, 1910, 1914, 1943, and 1952. So far as is known, there have been no disastrously damaging dry-mantle floods in the watershed, (see Chronology of Flood Years).

Erosion Damage

A preponderant portion of the past flood damage has occurred in the form of channel cutting along the courses of South Fork and Milligan Creek on the South Fork, particularly along its channel between North Fork and Milligan Creek, and along the reaches of Milligan Creek, excessive livestock use, the erosive cutting and deepening of the stream channels, and the resultant lowering of the water table have brought about the replacement of many meadow species by phreatophytic rabbitbrush and greasewood.

It is estimated that approximately five to 10 miles of intermittent stream channels tributary to South Fork and about 20 miles of the Milligan Creek main channel are still actively cutting.

Sediment Damage

There probably would be no sediment damage to the benefit area along South Fork between the Latons Spring dam site and North Fork, or to the benefit area between Sheldon Lane and Gumboot Lake which would be dependent upon both this and the North Fork watersheds. Observations made on the irrigated land at the vicinity of the Latons Spring dam site indicate sediment deposits at the upper ends of the fields. In view of the number of years involved in building these present deposits, it is reasonable to assume that the sediment yields have been moderate. No attempt was made to compute the total volume of sediment present in the fields, nor the average annual deposition.

Vegetation - Kind and Condition

Phreatophytes

Phreatophytes are located along both South Fork and Milligan Creek. The principal species is rubber rabbitbrush, with smaller amounts of greasewood. Practically all of the phreatophyte acreage on South Fork occurs about four miles upstream from Milligan Creek. A n extensive flat, formerly a ryegrass meadow dessicated by channel cutting along South Fork, has reverted to a rather heavy growth of rabbitbrush intermixed with limited amounts of greasewood.

A similar situation exists on Milligan Creek, where scattered stringer meadows along the stream course have reverted to rabbitbrush and greasewood. This reversion was also brought about by the same causative agent: drainage of the meadow areas by stream channel erosion.

In the benefit area there are willows along the channel of Little Humboldt River, and scattered throughout the hay fields. Also in the benefit area below Sheldon Lane,Great Basin wildrye and creeping wildrye grow in these meadows, with large areas of greasewood and rabbitbrush along their fringes. In the valley above Gumboot Lake are extensive areas of saltgrass and alkali sacaton.

Table 11 furnishes additional information on the phreatophyte species found on the watershed, and also on the benefit area.

Range Forage Production

Table 12 furnishes a breakdown of range forage production acreage, present and potential, by vegetal type, site, and soil associations.

The area of highest range forage production in the watershed is in the high basins and upper slopes of the Snowstorm Mountains, at the head of South Fork. There still survives a considerable acreage of bluebunch wheatgrass, most of which is in the medium to fairly high forage production classes. The rangelands for the remainder of the watershed are in the low forage production class, except for scattered areas of medium range forage production.

Fire Protection

The fire protection problems are discussed in the sub-basin report.

Table 11 -- Phreatophyte acreage and annual ground water use, South Fork watershed

Species	Height class	Density	1/ Acreage range types	Acres 1/ irrigated hay & meadows	Annual ground water use 1/ (feet)	(acre-feet)
Black greasewood	0'-3'	.15-.20	15,300	----	0.25	3,800
	3'+	.20-.40	1,200	----	0.40	500
Rubber rabbitbrush	3'+	.20-.40	2,700	----	0.40	1,100
Willow	5'-8'	.25-.40	2,200	----	2.30	5,050
Saltgrass	----	.20-.30	11,200	----	0.50	5,600
Great Basin wildrye	----	.20-.50	2,950	----	1.00	2,950
Great Basin wildrye	----	-------	------	2,400	0.50	1,200
Creeping wildrye	----	.20-.50	6,000	----	1.00	6,000
Creeping wildrye	----	-------	------	2,500	0.50	1,250
Alkali sacaton	----	.20-.50	8,100	-----	0.50	4,050
Alfalfa	----	-------	------	1,850	0.50	900
Totals			49,650 1/	6,750 1/		32,400 1/

1/ The benefit area below Sheldon Lane in Paradise Valley and the Little Humboldt River below the Latons Spring dam site are included in these values.

Table 12. --Acreage classes of present and potential annual forage plant production, grouped by soils for each vegetal type and site, South Fork watershed

Vegetal type and site	Present annual forage plant production classes (acres)			Potential annual forage plant production classes (acres)			Treatment needed to reach potential
1. Rabbitbrush-greasewood-grass; saline bottom-lands	Rates of forage prod. 1/2/ (pounds per acre)			Rates of forage prod. 1/2/ (pounds per acre)			
Soil associations	850-1500	200-600	20-200	850-1500	200-600	20-200	
H4-A4	--------	-------	2,800	2,800	-------	------	Clear brush, proper management and stocking
Sub Total			2,800	2,800			
2. Big sagebrush-grass; upland benches and terraces	Rates of forage prod. 1/2/ (pounds per acre)			Rates of forage prod. 1/2/ (pounds per acre)			
Soil associations	250-600	100-450	20-150	250-600	100-450	20-150	
B3-P1-C1-L2	-------	14,700	132,100	6,800	60,000	80,000	Clear brush, reseeding, proper management and stocking, fencing, meadow restoration
S7-R9-L3	-------	20,500	22,800	20,500	12,800	10,000	Spraying 3/, proper management and stocking, fencing
Sub Total		35,200	154,900	27,300	72,800	90,000	

Continued

Table 12. -- Acreage classes of present and potential annual forage plant production, grouped by soils for each vegetal type and site, South Fork Watershed -- Continued

Vegetal type and site	Present annual forage plant production classes (acres)			Potential annual forage plant production classes (acres)			Treatment needed to reach potential
3. Browse-aspen-grass; north and east slopes and basins	Rates of forage prod. 1/2/ (pounds per acre)			Rates of forage prod. 1/2/ (pounds per acre)			
Soil associations	300-650	150-500	50-200	300-600	150-500	50-200	
R1-B1-L1	18,400	23,700	44,300	41,000	35,400	10,000	Spraying 3/4/, proper management and stocking, fencing
Sub Total	18,400	23,700	44,300	41,000	35,400	10,000	
Totals	18,400	58,900	202,000	71,100	108,200	100,000	

1/ These figures indicate total annual forage production, and will be used as a basis for planning needs only. Forage production figures will not be used for assigning range carrying capacities. These carrying capacities will depend upon such factors as slope, soil depth, soil character and stability, and the management objectives of the administrative agency.

2/ These rates represent production variance from poor years to good years. At higher elevations within the site, with greater precipitation the rates would be higher, and conversely for lower elevations.

3/ Does not include localized rabbitbrush areas.

4/ Includes localized decadent ranges now predominantly sagebrush.

Source: Humboldt River Basin Field Party.

Recreation and Wildlife

Recreation Developments

The aspen-browse cover on the remote but very scenic north exposures of the Snowstorm Mountains has a strong potential for recreation area development. To make the area accessible for recreation use, however, it would be necessary to construct suitable access roads. To be certain that this Snowstorm Range warrants further consideration as a potential recreation site, it should first be determined whether sufficient springs or seeps are available for campground water development.

Any selection of recreation sites in the Snowstorms should recognize the fact that aspen alone, as a cover type for family camp or picnic units, is intolerant of human pressure, and will eventually be eliminated. Advantage should be taken of hardier and longer-lasting mixed aspen-browse or tall browse cover in the planning and development of recreation sites here.

Fish and Wildlife

As there are no stream channel habitat improvements, fishing lakes or pond construction contemplated on any of the streams within this watershed area, there will be no necessity to plan for any water supply or use for this type of development. The runoff from the watershed would not be sufficient in most years to furnish a carryover storage at the proposed Latons Spring reservoir site adequate to support a fish population of any significant proportions.

Opportunities for Development

Agricultural Water Management

Structural Measures

An earthen dam about 970 feet long and 56 feet high is proposed at the Latons Spring site. The reservoir would have a capacity of about 10,800 acre-feet, allowing 5,800 acre-feet for irrigation and 5,000 acre-feet for flood prevention.

The benefit area would need some structural work to make the best use of this water. These measures are of mutual concern to this as well as the North Fork watershed. It is estimated that about five diversions, 40 miles of supply ditch, and the necessary headgates, turnouts and drops would be needed along the Little Humboldt River and an additional three miles along the South Fork channel, between the Latons Spring site and North Fork.

Ground Water Development

It is possible that additional ground water developments can be made to irrigate land in addition to that proposed for surface water use. The water table could be lowered to a depth that would reduce the water use by phreatophytes.

Land Treatment Measures

The reservoir water would be concentrated on a relatively small acreage growing higher-yielding forage crops. The amount of land that could be irrigated, at least 80 percent of the years, is estimated to be 1,100 acres. Of these about 900 acres would need land leveling.

New irrigation water distribution systems would have to be established. Only the best and most accessible land belonging to each owner would be cultivated.

Watershed Protection

The South Fork headwaters in the Snowstorm Mountains contain some of the best pristine bluebunch wheatgrass range watershed cover on the national land reserve lands of the entire Little Humboldt Sub-Basin. These lands are intermingled with considerable private land holdings along the lower and middle reaches of South Fork.

Milligan Creek, unlike South Fork, has suffered much range abuse and deterioration, because of the generally lower and flatter terrain and consequently more open and accessible range area. Most of the misuse occurred during the years of unrestricted year-round use by livestock prior to the establishment of control under the Taylor Grazing Act in 1935.

The watershed rehabilitation measures outlined in the following pages are by no means definitive. Further and more intense study of the area will doubtless suggest additions and improvements to the list.

Structural Measures

1. Stream channel structures. - Channel stabilization by bank sloping and reseeding, and erosion control structures along the main channel of Milligan Creek. At least 12 miles of the upper and middle reaches of Milligan Creek need such treatment.
2. Stockwater reservoirs. - Accelerate the Bureau of Land Management's present program of small stockwater reservoir construction.
3. Fencing of range allotments. - Accelerate the fencing program in connection with the Bureau of Land Management's range adjudication program.

Land Treatment Measures

1. Range reseeding. - Reseed all suitable sites in medium to low range forage production lying between South Fork and the upper and middle reaches of Milligan Creek.
2. Control of sagebrush. - The range areas on the high benchlands immediately north of the Snowstorms are in a medium to fairly high forage production class, and there is probably sufficient bluebunch wheatgrass - Sandberg bluegrass cover left to warrant control of the sagebrush overstory.

Flood Prevention

Flood prevention measures are those which are included in Agricultural Water Management - Structural Measures, and Watershed Protection - Structural Measures, and Land treatment.

Vegetal Manipulation

Approximately five miles up South Fork from its junction with Milligan Creek lies a former ryegrass meadow, about 100 acres in size. This former meadow, situated where the South Fork-Milligan Creek road crosses South Fork, has reverted to a heavy stand of rubber rabbitbrush over three feet in height. This stream bottom could be returned to an approximation of its former meadowland composition by removal of the rabbitbrush on the area.

There are about 2,000 acres of phreatophytes above the North Fork confluence. The remainder of the phreatophytes use water from both the South and North Fork drainages, below this junction. It is estimated that about 10,000 acres of rabbitbrush, greasewood, and other brush-type plants can be cleared, giving the wildrye understory a chance to spread. Approximately 10,000 AUM's of additional grazing could be obtained by this treatment. Of this total, about 8,000 AUM's would be in conjunction with the North Fork watershed in the benefit area, and 2,000 AUM's would be in the South Fork watershed.

Benefits Expected

Agricultural Water Management

The proposed irrigation reservoir would provide late spring and summer water for the irrigated lands. This would allow a more stable cropping program to be developed. Water in excess of reservoir capacity would be available for the irrigation of pasture land.

By reducing the irrigated acreage now being used for hay production, the bottom land pastures could be increased by about 4,000 acres, thereby relieving the Federal and private range use by an estimated 4,000 AUM's.

Lowering the water table by pumping, so as to stop the phreatophytic water use as much as is practical, would increase the water supply by an estimated 10,000 acre-feet. This new water could increase the irrigated acreage by about 2,500 acres.

The benefits expected on irrigated lands would be as follows:

1. Better seasonal distribution of irrigation water.
2. Higher irrigation efficiency.
3. Partial flood control.
4. Production of higher quality hay.
5. More efficient use of labor.

Watershed Rehabilitation

The opportunities for development, insofar as they concern watershed protection in the area, would benefit the Milligan Creek channel by stabilizing it with structures. Stock-water reservoirs would improve cattle distribution by reducing use along the stream bottoms, and facilitate better utilization on range areas now little used because of a lack of stock-water. Fencing of range allotments on the national land reserve would be of value in affording more positive control of livestock.

These benefits should result in a more uniform year-round flow of water, and better quality water, from South Fork and Milligan Creek into the proposed Latons Spring reservoir, minimizing the sedimentation there. In terms of range forage improvement, all the expected benefits are reflected in table 12. It is estimated that over a period of 50 years the acreage of fairly high forage production range could be increased almost four times, while the acreage of low forage production range would be decreased about 50 percent.

Flood Prevention

The proposed reservoir and watershed treatment measures would give partial relief to the cultivated areas from flood waters originating in the South Fork and Milligan Creek drainages.

Vegetal Manipulation

There are an estimated 10,000 acres of brush-type phreatophytic plants that could be cleared in the project area and benefit area combined. This could give relief to the Federal and private range use by about 10,000 AUM's. Approximately 8,000 of these AUM's would be in conjunction with the North Fork watershed.

Conclusions

The watershed and range deterioration now evident on much of this watershed, and the resultant decrease in range forage production, has affected - and still is affecting - the livestock industry. These conditions could be changed for the better by the achievement of a heavier annual forage crop production. This could be brought about through adjustment to proper stocking where needed, fencing the cattle allotments on the Federal ranges, and utilizing them under proper management. It is estimated that over a period of 50 years the acreage of fairly high forage production range could be increased almost four times, while the acreage of low forage production range would be decreased about 50 percent.

Approximately 10,000 AUM's of additional pasturage could be provided on 10,000 acres of land in the benefit areas by phreatophyte removal on selected sites. About 8,000 of these AUM's would be in conjunction with the potential North Fork watershed. The increased pasturage could be utilized to relieve some of the grazing pressure on Federal range in the sub-basin.

Benefits can also be expected from the stabilization and rehabilitation of the higher watershed areas, brought about through the application of the watershed land treatment and structural measures suggested. This would result in a more uniform flow of higher quality water from South Fork and Milligan Creek.

The proposed Latons Spring reservoir would furnish approximately 5,800 acre-feet of irrigation water on the benefit areas for the watershed, and about 5,000 acre-feet for flood prevention storage. There are very few acres of irrigated cropland within the potential project; most of the area is Federal range. The irrigated lands which would benefit from the proposed reservoir lie along South Fork below the proposed reservoir, and in lower Paradise Valley. This latter area would receive equal benefits from the North Fork watershed. The reservoir water would be concentrated on about 1,100 acres of land for hay production, which would release about 4,000 acres now being cropped for hay to the production of an additional 4,000 AUM's of pasture.

SOILS DESCRIPTION

The generalized soil survey of the Little Humboldt Sub-Basin shows the location and distribution of different kinds of soils by associations of Great Soil Groups. Each Great Soil Group includes a number of soils with similar internal characteristics that reflect the environmental conditions responsible for their development. Great Soil Groups mapped in the survey include:

Alluvial Soils (Symbol: A)

These are the soils that consist of essentially recent stream-laid deposits; alluvial fans, floodplains, terraces and basins. They have essentially no profile development, but a little organic matter may have accumulated. They are usually deep, stratified, variable with regard to drainage class, and occur under many different climates.

Brown Soils (Symbol: B)

These are the soils which have dark brownish A horizons about six inches thick, textural B Horizons 10 to 15 inches thick, and calcareous parent material of variable thickness. Some of these soils have cemented calcium carbonate layers in the C horizon and some may have the C horizon resting on bedrock. They are usually moderately deep to deep, well drained, and occur under a cool semi-arid climate with an average precipitation of 10 to 16 inches. Most of the Brown Soils in the Little Humboldt Sub-Basin occur at elevations above 5,000 feet, in the uplands.

Calcium Carbonate Solonchak (Symbol: X)

Soils of floodplains and basins, with gray to black friable granular A horizons six to 15 inches thick, which grade into strongly calcareous grayish brown to white calcium carbonate horizons. The depth to the calcium carbonate horizon is dependent upon the depth to the water table. They are usually imperfectly to poorly drained.

Chestnut Soils (Symbol: C)

These soils have dark grayish brown to very dark grayish brown A horizons about six to eight inches thick, textural B horizons 10-15 inches thick, and parent material that may or may not be calcareous. These soils usually have darker A horizons, more organic matter, and have been more strongly leached than have the Brown Soils. The parent material may or may not rest on bedrock. They are usually moderately deep to deep, well drained, and occur in a cool semi-arid climate with an average precipitation of 14 to 25 inches. Most of the Chestnut Soils in the Little Humboldt Sub-Basin occur at elevations above 5,500 feet, in the uplands.

Humic Gley Soils (Symbol: H)

These are the dark brown or black meadow soils that grade into lighter colored or rust-mottled grayish soil, or both, at depths of one to two feet. They are imperfect to poorly drained, usually with a seasonal fluctuating high water table, and occur along stream

floodplains where they are subject to overflow. They occur in a cool semi-arid climate, and are found in the Little Humboldt Sub-Basin at elevations mostly below 5,000 feet.

Lithosols (Symbol: L)

These soils have an incomplete profile, or no clearly expressed morphology. They are shallow (less than 10 to 15 inches), consist of freshly and imperfectly weathered masses of hard rock or hard rock fragments, and are largely confined to steeply sloping lands. In the higher rainfall areas of the sub-basin, some of these soils may have dark A horizons. They are usually excessively drained.

Planosols (Symbol: P)

These are soils occurring on smooth-sloping alluvial fans and volcanic plains. They have a leached light colored A horizon that is usually thin (three to four inches), over a compact, dense claypan. The claypan may vary in thickness from about eight to 24 inches, and may be underlain by parent material or bedrock. In the Little Humboldt Sub-Basin they occur under a cool, semi-arid climate, with an average annual precipitation of 10 to 25 inches, at elevations above 5,000 feet. They are usually moderately well drained, being saturated with water during the winter and early spring months.

Regosols (Symbols: R)

These are soils which consist of deep unconsolidated deposits, in which few or no clearly expressed soil characteristics have developed. They are largely confined to recent sand dunes and colluvial accumulations on steep mountain slopes. Under eight to 10 inch rainfall the Regosols may have only a weakly developed A horizon, while in higher rainfall areas they may have well developed dark A horizons six to 14 inches or more thick. In mountainous areas these soils may be underlain by bedrock 15 to 20 inches below the soil surface.

Sierozems (Symbols: S)

These are soils with pale grayish or light brownish surface soils and textural B horizons closely related in color to the surface soil. They are usually calcareous in the B horizon, and frequently also in the surface soil. They quite often have a cemented calcium carbonate hardpan at shallow to moderate depths below the B horizon. The B horizon in the Sierozem Soils in this sub-basin is usually weakly developed and difficult to identify. In mountainous areas the Sierozems may be underlain by bedrock at moderate depths. These soils are found in a semi-arid cool climate, with an average annual precipitation of about eight to 10 inches, and mostly at elevations below 5,000 feet.

Solonetz (Symbol: Y)

These are imperfectly drained soils with a few inches of light grayish or brownish surface soil underlain by a hard columnar fine textured horizon that is high in exchangeable sodium. They occur on floodplains, terraces, and some alluvial fans, usually as small areas associated with saline-alkali Alluvial Soils, Humic Gley Soils, and Calcium Carbonate Solonchaks.

Mapping Units

Mapping units on the generalized soil survey map of the Little Humboldt Sub-Basin are associations of phases of Great Soil Groups that reflect characteristics of soils significant to use and management. Each mapping unit symbol includes the designation of approximate composition percentage for each Great Soil Group that comprises the association.

Example: $\frac{\text{Ll-Cl-Rl}}{\text{60-20-20}}$

SOILS TABLES

The following tables show the general soil characteristics (table 13), with interpretations for each Great Soil Group phase (table 14) that was mapped in the sub-basin.

Table 13. --Soil characteristics, Little Humboldt Sub-Basin

Soil Phase	Depth	Texture		Slope Range %	Erosion	Salt & alkali	Drainage	Remarks
		Surface	Subsoil					
A1	Deep	Coarse to medium	Medium to moderately fine	2-8	Slight	None	Well to mod. well	5% mod. eroded
A2	Deep	Medium & gravelly medium	Medium	2-15	Slight	None	Well	25% stony soils, 10% mod. eroded, seedable
A3	Deep	Medium	Medium	2-4	Slight	Slight	Well to mod. well	5% mod. eroded
A4	Deep	Medium	Medium	0-2	Slight	Slight	Imperfect	Overflowed
A5	Deep	Medium	Medium	0-2	Slight	None to slight	Mod. well to well	20% seedable, 10% overflowed, some gullying
A6	Deep	Medium to moderately fine	Medium to moderately fine	0-2	Slight	Mod. to strong	Imperfect to poor	
A7	Shallow to moderately deep	Medium & gravelly medium	Gravelly medium & medium	0-4	Slight	None	Somewhat excessive	5% mod. eroded, small areas suited to reseeding
A8	Deep	Medium	Medium	2-8	Slight	None	Mod. well	20% stony soils, 10% mod. eroded
A9	Deep	Medium & moderately coarse	Medium to moderately coarse	0-25	Slight	Slight to mod.	Mod. well	Water table 6-10 ft. overblown with fine sand
A10	Deep	Medium	Medium	2-4	Slight	None	Well	5% mod. eroded
A11	Deep	Medium	Medium to moderately fine	2-8	Slight	None	Well	15% mod. eroded, seedable
A12	Deep	Medium	Medium to moderately fine	0-2	Slight	None to slight	Imperfect	Small areas of range
B1	Moderately deep to deep	Medium	Medium to moderately fine	30-50	Slight	Slight	Well	15% mod. eroded, hill creep

Table 13. --Soil characteristics, Little Humboldt Sub-Basin -- Continued

Soil Phase	Depth	Texture		Slope Range %	Erosion	Salt & alkali	Drainage	Remarks
		Surface	Subsoil					
B2	Moderately deep to deep	Medium	Medium to moderately fine	4-15	Slight	None	Well	5% mod. eroded, small areas cropland, seedable
B3	Moderately deep to deep	Medium, stony & very stony med.	Medium, moderately fine to fine	4-30	Slight	None	Well	25%-30% stony soils, 10% mod. eroded, 10% deep (over 36")
X1	Deep	Mod. fine	Mod. fine to fine	0-2	Slight	Slight to strong	Imperfect to poor	
C1	Moderately deep to deep	Stony med. and med.	Medium to moderately fine	30-50	Slight	None	Well	15% mod. eroded, 10% very stony, 10% deep Chestnut soils
C2	Moderately deep to deep	Medium	Medium to moderately fine	4-15	Slight	None	Well	10% mod. eroded, 15-25% stony soils
H1	Deep	Medium	Medium	0-2	Slight	Slight	Imperfect	Overflowed
H2	Deep	Medium	Medium	0-2	Slight	None	Imperfect to poor	
H3	Deep	Medium and fine	Medium to moderately fine	0-2	Slight	Slight	Poor	Overflowed
H4	Deep	Medium	Medium to moderately fine	0-2	Slight	None	Poor	Overflowed
L1	Shallow over bedrock	Stony and rocky med.		50-70	Slight	None	Excessive	20% mod. eroded
L2	Shallow over bedrock	Stony and rocky med. to coarse		50-70	Slight	None	Excessive	20% mod. eroded
L3	Shallow over bedrock	Stony and rocky med. to coarse		50-70	Slight	None	Excessive	20% mod. eroded

Continued

Table 13. --Soil characteristics, Little Humboldt Sub-Basin -- Continued

Soil Phase	Depth	Texture: Surface	Texture: Subsoil	Slope Range %	Erosion	Salt & alkali	Drainage	Remarks
P1	Shallow	Stony med.	Medium	4-15	Slight	None	Somewhat excessive	5% mod. eroded
R1	Moderately deep to deep	Stony & gravelly medium	Stony & gravelly medium	30-60	Slight	None	Somewhat excessive	15% mod. eroded
R2	Moderately deep to deep	Coarse	Coarse	4-30	Moderate	None	Excessive	10% active duneland
R3	Moderately deep to deep	Stony & gravelly medium	Medium	50-70	Slight	None	Somewhat excessive	25% mod. eroded
R4	Moderately deep to deep	Coarse	Coarse	2-7	Moderate wind	None	Excessive	5% active duneland
R5	Moderately deep to deep	Stony & gravelly medium	Medium	30-50	Slight	None	Somewhat excessive	15% mod. eroded
R6	Moderately deep to deep	Stony & gravelly medium	Medium	15-30	Slight	None	Well	50% mod. eroded
R7	Moderately deep to deep	Stony & gravelly medium	Medium	30-50	Slight	None	Well	15% mod. eroded
R8	Moderately deep to deep	Stony & gravelly medium	Medium	4-15	Slight to mod.	None	Well	5% rock outcrop, 30% mod. eroded
R9	Moderately deep to deep	Stony & gravelly medium	Medium	8-15	Slight	None	Well	5% rock outcrop, 10% mod. eroded
S1	Moderately deep to deep	Medium & gravelly medium	Med. to moderately fine	4-15	Slight	None	Well	Seedable, 20% stony, 15% mod. eroded
S2	Shallow to moderately deep	Medium & gravelly medium	Medium	2-8	Slight	None	Well	20% mod. eroded
S3	Moderately deep to deep	Stony medium	Medium	15-30	Slight	None	Well	15% mod. eroded
S4	Moderately deep to deep	Medium	Medium	2-15	Moderate gullying	None	Well	20% stony soils

Continued

Table 13. --Soil characteristics, Little Humboldt Sub-Basin --Continued

Soil Phase	Depth	Texture		Slope range %	Erosion	Salt & alkali	Drainage	Remarks
		Surface	Subsoil					
S5	Moderately deep to deep	Medium & gravelly medium	Medium	8-15	Moderate gullying	None	Well	20% stony soils, 20% severely eroded
S6	Shallow to moderately deep	Medium	Medium	8-15	Moderate gullying	Slight	Well	15% stony soils
S7	Moderately deep to deep	Medium and mod. coarse	Medium and mod. coarse	2-8	Slight	None	Well	15% moderately eroded, 15% stony soils
Y1	Deep	Medium and mod. fine	Moderately fine to fine	0-3	Slight	Moderate to strong	Imperfect to mod. well	5% severely eroded

Source: Humboldt River Basin Field Party

Table 14. --Interpreted soil characteristics, Little Humboldt Sub-Basin

Soil Phase	Precip. zone (inches)	Erosion hazard	AWHC 1/ (inches)	Soil Hydro-logic Group	Capa-bility Sub-class	Major land use	Dominant vegetation
A1	8-10	Slight	12	C	VIIs	Range	Big sage-grass
A2	8-10	Slight	8	B	VIc	Range	Big sage-grass
A3	8-10	Slight to moderate	10	C	VIIc	Range	Shadscale-budsage, squirrel-tail
A4	8-10	Slight	10	B	IIIw	Irrigated crops	Alfalfa-small grain
A5	8-10	Slight	9	C	IIw VIc	Irrigated crops & range	Shadscale-budsage-grease-wood grass
A6	8-10	Slight	12	D	VIIs	Range	Greasewood-saltgrass, rabbit-brush-saltgrass
A7	8-16	Moderate	3	B	VIIs	Range	Big sage-grass
A8	10-14	Moderate	12	B	IIw VIc	Cropland & range	Big sage-grass
A9	8-10	Slight	8	B	VIIs	Range	Greasewood-rabbitbrush, bud-sage, shadscale, cheatgrass
A10	8-10	Slight to moderate	12	C	VIIc	Range	Winterfat-budsage, Indian ricegrass
A11	14-18	Moderate	12	B	VIc	Range	Big sage-grass, rabbitbrush, Sandberg bluegrass
A12	8-10	Slight	12	B	IIw	Cropland	Big sage-greasewood, rabbit-brush, grass
B1	10-16	Moderate	4	C	VIIe	Range	Big sage-grass
B2	10-16	Moderate	6	C	VIc	Range	Big sage-grass
B3	10-12	Moderate	8	C	VIc VIIc	Range	Big sage-grass
C1	14-25	Moderate	6	C	VIIe	Range	Big sage-bitterbrush, grass
C2	14-25	Moderate	8	C	VIc	Range	Big sage-grass
C3	14-25	Slight	6	C	VIIe	Range	Big sage-grass

Continued

Table 14. --Interpreted soil characteristics, Little Humboldt Sub-Basin -- Continued

Soil Phase	Precip. zone (inches)	Erosion hazard	AEHC 1/ (inches)	Soil Hydro-logic Group	Capa-bility sub-class	Major land use	Dominant vegetation
H1	8-10	Slight	12	B	IIw	Meadow hayland and pasture	Meadowgrass
H2	8-10	Slight	12	B	IIw	Meadow hayland and pasture	Meadowgrass
H3	8-10	Slight	12	D	IIIw	Meadow hayland and pasture	Meadowgrass
H4	8-10	Slight	10	C B	IIIw	Meadow hayland and pasture	Meadowgrass
L1	10-14	Moderate	1.5	D	VIIs	Range & water-shed	Low sage-grass
L2	10-25	Moderate	1.5	D	VIIs	Range & water-shed	Low sage-grass
L3	8-10	Moderate	1.5	D	VIIs	Range	Low sage-grass
P1	10-25	Moderate	3	D	VIIs	Range	Low sage-grass
R1	10-14	Moderate	6	C	VIIe	Range & water-shed	Big sage-grass, bitterbrush
R2	8-10	Moderate	5	A	VIIs	Range	Big sage-grass
R3	14-25	Moderate	5	C	VIIe	Range & water-shed	Big sage-grass
R4	8-10	Moderate	6	A	VIIs	Range	Rabbitbrush, spiny hopsage, grass
R5	8-10	Moderate	6	C	VIIe	Range	Big sage-grass
R6	8-10	Moderate	4	C	VIIe	Range	Big sage-grass
R7	14-25	Moderate	6	C	VIIe	Range & water-shed	Big sage-bitterbrush, grass
R8	14-25	Moderate	6	C	VIIe	Range & water-shed	Big sage-bitterbrush, grass
R9	8-10	Moderate	4	C	VIIe	Range	Big sage-grass
S1	8-10	Slight to moderate	6	C	VIc	Range	Big sage-grass
S2	8-10	Moderate	3	D	VIIs	Range	Shadscale-budsage-grass

Continued

Table 14. --Interpreted soil characteristics, Little Humboldt Sub-Basin -- Continued

Soil Phase	Precip. zone . (inches)	Erosion hazard	AWHC 1/ (inches)	Soil Hydro-logic Group	Capa-bility sub-class	Major land use	Dominant vegetation
S3	8-10	Moderate	4	C	VIIe	Range	Big sage-grass, spiny hopsage
S4	8-10	Moderate	6	C	VIc VIIe	Range, non-stony areas seedable	Big sage-grass
S5	8-10	Moderate	4	C	VIc VIIc	Range, small areas seedable	Big sage-grass
S6	8-10	Moderate	4	D	VIIs	Range	Shadscale-budsage
S7	8-10	Moderate	5	C	VIc	Range	Big sage-grass, spiny hopsage
X1	8-10	Slight	9	D	Vw VIw	Pasture and range	Saltgrass, sacaton
Y1	8-10	Slight	12	D	VIIs	Range, small amounts crop-land	Greasewood-saltgrass

1/ Available water holding capacity

Source: Humboldt River Basin Field Party

DEFINITIONS

Hydrologic Soil Groups

Watershed soil determinations are used in the preparation of hydrologic soil-cover complexes, which in turn are used in estimating direct runoff. Four major soil groups are used. The soils are classified on the basis of intake of water at the end of long-duration storms occurring after prior wetting and opportunity for swelling, and without the protective effects of vegetation.

Group A - Soils having high infiltration rates even when thoroughly wetted, consisting chiefly of deep, well to excessively well drained sands and/or gravel. These soils have a high rate of water transmission and would result in a low runoff potential.

Group B - Soils having moderate infiltration rates when thoroughly wetted, consisting chiefly of moderately deep to deep, moderately well to well drained soils with moderately fine to moderately coarse textures. These soils have a moderate rate of water transmission.

Group C - Soils having slow infiltration rates when thoroughly wetted, consisting chiefly of (1) soils with a layer that impedes the downward movement of water, or (2) soils with moderately fine to fine texture and slow infiltration rate. These soils have a slow rate of water transmission.

Group D - Soils having very slow infiltration rates when thoroughly wetted, consisting chiefly of (1) clay soils with a high swelling potential, (2) soils with a high permanent water table, (3) soils with a claypan or clay layer at or near the surface, and (4) shallow soils over nearly impervious materials. These soils have a very slow rate of water transmission.

Land Use Capability Classes and Subclasses

The capability classification is a practical grouping of soils. Soils and climate are considered together as they influence use, management, and production on the farm or ranch.

The classification contains two general divisions: (1) Land suited for cultivation and other uses; and (2) Land limited in use and generally not suited for cultivation. Each of these broad divisions has four classes which are shown by a number. The hazards and limitations in use increase as the class number increases. Class I has few hazards or limitations, or none, whereas Class VIII has a great many.

Capability classes are divided into subclasses. These show the principal kinds of conservation problems involved. The subclasses are "e" for erosion, "w" for wetness, "s" for soil, and "c" for climate.

Capability classes and subclasses, in turn, may be divided into capability units. A capability unit contains soils that are nearly alike in plant growth and in management needs.

Land Suited for Cultivation and Other Uses

Class I — Soils in Class I have few or no limitations or hazards. They may be used safely for cultivated crops, pasture, range, woodland, or wildlife.

Class II — Soils in Class II have few limitations or hazards. Simple conservation practices are needed when cultivated. They are suited to cultivated crops, pasture, range, woodland, or wildlife.

Class III — Soils in Class III have more limitations and hazards than those in Class II. They require more difficult or complex conservation practices when cultivated. They are suited to cultivated crops, pasture, range, woodland, or wildlife.

Class IV — Soils in Class IV have greater limitations and hazards than Class III. Still more difficult or complex measures are needed when cultivated. They are suited to cultivated crops, pasture, range, woodland, or wildlife.

Class V — Soils in Class V have little or no erosion hazard but have other limitations that prevent normal tillage for cultivated crops. They are suited to pasture, range, woodland, or wildlife.

Class VI — Soils in Class VI have severe limitations or hazards that make them generally unsuited for cultivation. They are suited largely to pasture, range, woodland, or wildlife.

Class VII — Soils in Class VII have very severe limitations or hazards that make them generally unsuited for cultivation. They are suited to grazing, woodland, or wildlife.

Class VIII — Soils and land forms in Class VIII have limitations and hazards that prevent their use for cultivated crops, pasture, range, or woodland. They may be used for recreation, wildlife, or water supply.

ANNUAL WATER BALANCE STUDY
80 PERCENT FREQUENCY

Annual Water Balance, as used in these studies, is the evaluation of a portion of the hydrological cycle. The cycle starts with precipitation on the watershed, and ends with the runoff, both surface and subsurface flow, after subtracting the losses.

The studies were made in the Little Humboldt Sub-Basin to develop a procedure that can be used in other drainages, particularly those watersheds without stream flow records, as an attempt to find answers to the following questions:

1. What is the gross water supply from the watersheds of the sub-basin?
2. What is the approximate magnitude of water used by each of the major ground cover types?
3. Where are the water yielding areas in the sub-basin and in each watershed?
4. Can vegetation manipulation be used to increase the water supply?

The annual water balances were calculated for an 80 percent occurrence. This frequency was used because such a water supply would be the quantity needed to justify land and irrigation improvement on the ranches, growing high-yielding crops.

Values obtained using this procedure are approximations. The accuracy expected would probably be in the range of 10 to 40 percent, the greater percentage being in ungaged watersheds where gaged drainages with similar characteristics cannot be found.

The annual water balance calculations for the major watersheds of the Little Humboldt Sub-Basin furnished the following information:

1. The runoff from the major drainages, for an 80 percent frequency runoff, would be around 40,000 acre-feet. This runoff value would be the total amount available prior to any irrigation use.
2. The major water producing area is the Santa Rosa Range, with Martin Creek and the North Fork being the watersheds that convey the greatest volume of flow.
3. There are no areas in the upper reaches of these drainages where a change in vegetation would have a measurable effect on water yield.

The annual water balance is shown graphically by figure 6, and represents a portion of the hydrological cycle for a site in the Santa Rosa Range in the 7,000 to 8,000 foot elevation zone, with a particular soil and ground cover.

Table 15 is a summary of the water balance studies for the principal drainages in the sub-basin. In this summary are calculated values for runoff (80 percent frequency) by elevation zones, at the stream gaging stations and above irrigation diversions.

Table 16 shows the yearly runoff above irrigation diversions, from the drainages within the sub-basin (1922-1960). The values in this table are an indication of past flows and what might be expected as runoff for 50 percent and 80 percent frequencies (equaled or exceeded).

Figure 6. - The Annual Water Balance for a Soil of Six Inch Available Water Holding Capacity With Herbaceous-Browse Type Ground Cover at the 7,000-8,000 Foot Elevation Zone in the Santa Rosa Range.

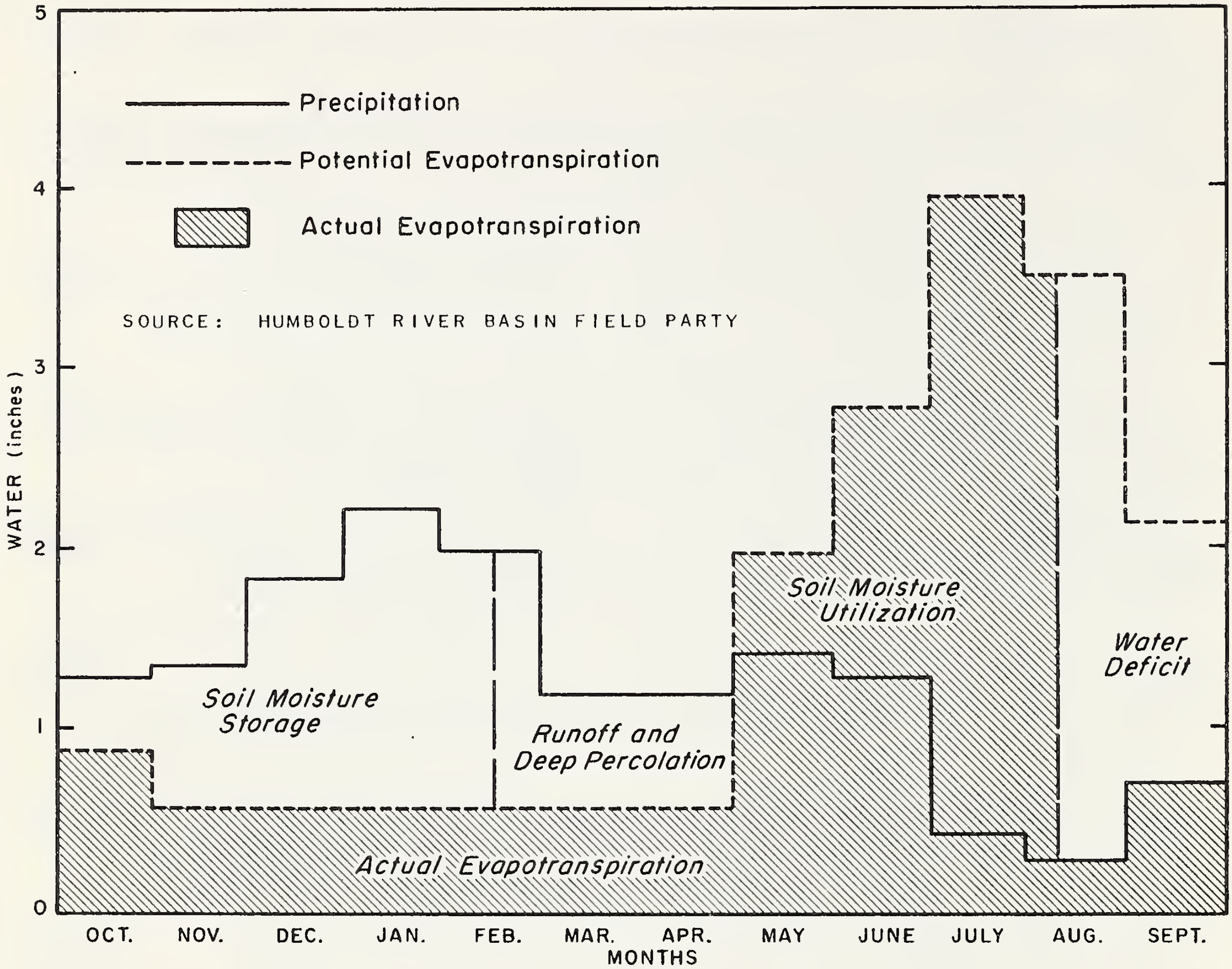


Table 15.--Summary of calculated runoff by elevation zones for watersheds in the Little Humboldt Sub-Basin for 80 percent year

Elevation zone (feet)	Martin Creek			Cottonwood Creek		
	Acres	Runoff		Acres	Runoff	
		acre-feet	in./ac.		acre-feet	in./ac.
8-9,800	2,720	1,993	8.79	1,254	927	8.87
7-8,000	15,120	5,804	4.60	5,658	2,198	4.66
6-7,000	50,350	4,700	1.12	8,960	833	1.12
5-6,000	46,080	730	.19	11,646	237	.24
4-5,000	-----	-----	----	8,679	-3,027	----
Total at gage	114,270	13,227	1.39	36,197	1,168	.39
Total above diver.	114,270	13,227	1.39	33,017	4,195	1.39

Elevation zone (feet)	N.F. Little Humboldt River			S.F. Little Humboldt River		
	Acres	Runoff		Acres	Runoff	
		acre-feet	in./ac.		acre-feet	in./ac.
8-9,800	190	142	8.97	770	385	6.00
7-8,000	8,190	3,209	4.70	10,370	2,315	2.68
6-7,000	57,805	3,795	.79	55,020	3,325	.73
5-6,000	69,885	1,289	.22	205,530	235	.02
4-5,000	14,980	-1,510	----	8,080	-490	----
Total at gage	151,050	4,698	.31 1/	279,770	5,770	.25 2/
Total above diver.	149,250	8,456	.67	276,470	6,230	.27

1/ Adjusted to Hot Springs gaging site.

2/ At Latons Spring dam site.

Source: Humboldt River Basin Field Party.

Table 16. --Runoff in acre-feet available for irrigation in the Little Humboldt Sub-Basin

Water year	Martin Cr. 1/	Little Humboldt R. 2/	Cottonwood Cr. & Tribs, 2/	Other Streams 3/	Total
1922	28,400	36,000	11,000	16,500	91,900
3	13,700	20,000	4,800	7,200	45,700
4	8,800	13,500	3,000	4,500	29,800
5	16,900	18,500	5,500	8,300	49,200
6	17,600	20,000	5,500	8,500	51,600
7	35,700	39,500	15,000	22,500	112,700
8	20,700	23,000	11,000	16,500	71,200
9	11,300	15,000	5,000	7,500	38,800
1930	13,500	17,000	5,500	8,500	44,500
1	5,910	10,000	1,800	2,700	20,410
2	33,200	34,000	13,500	20,300	101,000
3	13,500	17,500	4,500	6,800	42,300
4	8,640	13,000	3,000	4,500	29,140
5	21,360	24,000	8,000	12,000	65,360
6	19,910	22,000	7,500	11,300	60,710
7	16,590	20,500	5,200	7,800	50,090
8	34,240	38,000	15,000	23,000	110,240
9	15,760	19,000	5,000	7,500	47,260
1940	19,880	21,500	7,200	10,800	59,380
1	24,170	25,000	8,800	13,200	71,170
2	25,950	25,500	9,600	14,500	75,550
3	46,070	58,500	21,000	31,500	157,070
4	17,300	18,000	5,800	8,700	49,800
5	33,520	33,500	15,000	22,500	104,520
6	22,700	24,000	12,500	19,000	78,200
7	13,110	17,000	4,000	6,000	40,110
8	18,370	18,000	5,500	8,500	50,370
9	17,520	21,000	6,000	9,000	53,520
1950	25,170	23,000	11,500	17,000	76,670
1	27,860	30,500	10,000	15,000	83,360
2	63,940	73,000	28,000	42,000	206,940
3	18,710	18,500	6,800	10,200	54,210
4	8,400	13,000	2,300	3,500	27,200
5	10,090	14,000	3,300	5,000	32,390
6	31,090	26,000	12,000	18,000	87,090
7	29,720	32,500	11,500	17,300	91,020
8	43,900	45,000	17,500	26,300	132,700
9	10,280	14,500	3,600	5,400	33,780
1960	17,160	17,500	5,600	8,400	48,660
50% freq.	19,500	21,500	6,800	10,200	58,000
80% freq.	12,500	17,000	4,200	6,300	40,000

1/ U. S. Geological Survey gage record.
2/ Interpolated and adjusted from streamgage record, water balance studies, and runoff frequency curves.
3/ Estimated from water balance studies and runoff frequency curves of adjacent watersheds. Source: Humboldt River Basin Field Party.

DAILY WATER REQUIREMENTS-SPECIAL USE SITES

The following table 17 shows the daily water requirements for special use sites, Paradise Valley Ranger District, Humboldt National Forest.

Table 17. --Daily water requirements, special use sites, summer home and organization sites, Paradise Valley Ranger District, Martin Creek watershed.

Lot size	Approximate acreage	Location	Type of use	Dailey water requirements, gals.1/
105'x80'	0.20 acre	SE$\frac{1}{4}$SE$\frac{1}{4}$ Sec.13, T.44N., R.39E	Summer home site	20
100'x150'	0.35 acre	NE$\frac{1}{2}$NE$\frac{1}{2}$ Sec.19, T.44N., R.40E	Summer home site	35
60'x100'	0.14 acre	SE$\frac{1}{4}$SE$\frac{1}{4}$ Sec.13, T.44N., R.39E	Summer home site	15
50'x90'	0.10 acre	SE$\frac{1}{4}$SE$\frac{1}{4}$ Sec.13, T.44N., R.39E	Summer home site	10
75'x75'	0.13 acre	NE$\frac{1}{4}$NW$\frac{1}{4}$ Sec.26, T.44N., R.39E	Residence site to service T.V. Community antenna	15
Old Lamance Creek exper. sta. site	5.0 acres	NE$\frac{1}{4}$SW$\frac{1}{4}$ Sec.17, T.42N., R.39E	Humboldt County 4-H Club organization camp site	50
			Total daily water requirement	145

1/ Based upon a suggested minimum of 100 gallons per day per development acre, as developed by the National Forest Recreation Survey (N.F.R.S.), 1960.

Source: Humboldt National Forest

CHRONOLOGY OF FLOOD YEARS

An extensive search for material on floods, a little-known facet of the sub-basin history, was made in the newspaper files for Unionville, Winnemucca, Eureka, Elko, Wells, and Reno, supplemented by interviews with old residents, particularly in Paradise Valley. Reference was also made to all available stream flow records for the area. By this means, it has been possible to compile a rather complete list of the major floods (table 18) and high water periods (table 18A) in the Little Humboldt Sub-Basin, with resultant damages wherever known.

Table 18. -- Chronology of flood years, 1861-1961, Little Humboldt Sub-Basin

Month and year	Type	Damage and losses	Remarks
Dec.1861-Jan. 1862	Wet-mantle	Not known	Contributed to Humboldt flow through the Sand Dunes. Gumboot Lake developed.
Dec.1867-Jan. 1868	Wet-mantle	Not known	Humboldt River at Winnemucca and Cottonwood Creek overflowed. Heavy snows. Gumboot Lake formed.
Jan.13-May 25, 1881	Wet-mantle	Flooded mines, washed out mill dam and roads, damaged bridges, loss of cattle and communications	Gumboot Lake developed. Cottonwood Creek, Martin Creek, Little Humboldt and Humboldt Rivers overflowed. No breakthrough at the Sand Dunes.
Mar.7-June 5, 1890	Wet-mantle	Large livestock loss, property damage negligible, 100' flume washed out from old Martin Creek reservoir.	Gumboot Lake developed. Broke through the Sand Dunes. Deep snows, with canyons at head of Little Humboldt packed almost as solidly as ice (one canyon 100' deep). Paradise Valley one large sheet of water.
Mar.6-Apr. 16, 1907	Wet-mantle	Little physical damage. Land flooded.	Gumboot Lake developed. Broke through the Sand Dunes. Little Humboldt and Humboldt Rivers flooded (entire length).
Feb.18-Mar. 15, 1910	Wet-mantle	Bridges and ranches washed out, communications, freight and supply routes closed. Damages to Winnemucca, Battle Mt. & Elko	Gumboot Lake developed. Broke through the Sand Dunes. All tributaries of the Humboldt and Little Humboldt overflowed. Paradise Valley flooded (sheet of water at least 2 miles wide).

Continued

Table 18— Chronology of flood years, 1861-1961, Little Humboldt Sub-Basin

Month and year	Type	Damage and losses	Remarks
July 22-23, 1913	Dry-mantle	Damage to hay lands in Paradise Valley, and to Cottonwood-Lamance Creek watershed.	General flooding of east and west side Santa Rosa streams. Part of a series of state wide storms, July 18-25, which wreaked widespread damage.
Jan. 1-Apr. 1, 1914	Wet-mantle	Lowlands above Winnemucca flooded, and lower part of town. County bridge covered, and much soil damage.	Gumboot Lake developed. Broke through the Sand Dunes. All streams draining into Paradise Valley overflowed. Humboldt River overflowed at Elko, Palisade, Beowawe, and Carlin. Deep snow, up to 12' or more, in Santa Rosas. Flow in Humboldt River at County bridge, Winnemucca; 3 f./s. velocity; stream depth, 10.5 feet.
June 22, 1918	Dry-mantle	Damage to ranches and populated areas, including Winnemucca, Oreana, and Mill City, Rochester & Unionville, Nevada Short Line R.R. washed out between Oreana & Rochester. Silt deposition & mud-rock flow over meadows, stream erosion, roads washed out, watershed damage.	General flooding of Rebel, Willow, and Ten Mile creeks on west side of Santa Rosas. Portion west and northwest of town of Paradise Valley affected, which included Singas, Lamance, Cottonwood, Mullinix, Solid Silver, and Indian Creek drainages.

Continued.

Table 18. --Chronology of flood years, 1861-1961, Little Humboldt Sub-Basin --Continued

Month and year	Type	Damage and losses	Remarks
Dec. 1937-May 1938	Wet-mantle	Bridge washed out and stream damage.	Intermittent heavy snows with rain at lower elevations. Flood out of Cottonwood Creek and other streams at the head of Paradise Valley, through Paradise Valley town. Gumboot Lake formed.
Apr. 3-May 1, 1942	Wet-mantle	Stream, land and property damage on Humboldt main stem.	Humboldt main stem flooded from Elko to Lovelock. Little Humboldt River discharge was 244 C.F.S.; Martin Cr., 400 c.f.s. Not a big flood producer on Little Humboldt and tributaries. Gumboot Lake formed
Jan. 21-Jan.27, 1943	Wet-mantle	Damage to roads, bridges, ditches, etc.	Gumboot Lake formed. Martin Cr., 9,000 c.f.s.; Little Humboldt River 4,000 c.f.s.
Apr. 7- May 15, 1952	Spring snow-melt	Bridge and road washouts. Ranches flooded.	Gumboot Lake developed. Broke through the Sand Dunes. High snow accumulations. Cottonwood Creek, 1,050 c.f.s. High water on Martin, Indian, Singas, Lamance Creeks, etc. Little Humboldt, 5,371 c.f.s. in channel at Winnemucca.

Source: Humboldt River Basin Field Party.

Table 18A.--Chronology of high-water years (not flood producers, but Gumboot Lake formed), 1861-1961, Little Humboldt Sub-Basin

Month and year	Type	Damage and losses	Remarks
May-June, 1864	Spring snow-melt	Ranches and bottomlands submerged along Humboldt and Little Humboldt. Damage to hay crop.	All bottomlands flooded along Little Humboldt and Humboldt below Battle Mountain basin. Not a flood producer, as was 1862.
May-June 1865	Spring snow-melt	Ranches and bottomlands submerged along Humboldt and Little Humboldt. Damage to hay crop	All bottomlands flooded along Little Humboldt and Humboldt below Battle Mt. basin. Not a flood producer, as was 1862.
Jan. 16-19, 1875	Winter rain on snow	Ranches and bottomlands submerged on lower Little Humboldt and in Eden Valley	First actually recorded instance of formation of Gumboot Lake. Heavy snow, Jan. 16-18; heavy rain, Jan. 19-20.
1904	Spring snow-melt	None	1904, 238,100 a.f., 1899, 465,300 a.f. and 1897, 468,400 a.f.
1917	Spring snow-melt	None	Heavy snowpack along the Humboldt Basin.
Spring 1921	Spring snow-melt	Ranches submerged. Semi-flood conditions developed along Little Humboldt River (Bullhead Ranch and others).	Heavy snow on Buckskin Mt. (40 inches) and at head of Martin Creek and North Fork of the Little Humboldt.
May 1922	Spring snow-melt	None	Great percentage of yearly runoff came in a rush in May (12,000 a.f., Martin Creek, 12,400 a.f., Little Humboldt). Heavy snowpack was underlain by dry, unfrozen soil, which soaked up much of snowmelt.

Continued

Table 18A.--Chronology of high-water years (not flood producers but Gumboot Lake formed), 1861-1961, Little Humboldt Sub-Basin--Continued

Month and year	Type	Damage and losses	Remarks
April-May 1927	Spring snow-melt	None	Stream flow records for Martin Creek showed 35,700 acre-feet, and Little Humboldt River, 31,200 acre-feet.
March 1932	Spring snow-melt	None	Cottonwood Creek total yield for year was 7,180 acre-feet.
May 1945	Spring snow-melt	None	Heavy snowpack.
May 1950	Spring snow-melt	Not known.	No flood condition on Humboldt, Heavy flooding of streams in the Sierra Nevada including Truckee River flood at Reno in Dec. 1950.
May-June 1956	Spring snow-melt	Not known.	No flood condition on Humboldt. Heavy flooding of streams in the Sierra Nevada including Truckee River flood at Reno in Dec. 1955.
May 1958	Spring snow-melt	Not known.	Gumboot Lake partially drained by clearing the old Little Humboldt channel.

Source: Humboldt River Basin Field Party.

Plans for Future Recreation Developments - Humboldt National Forest

The National Forest Recreation Survey in the fall of 1960 completed an inventory of potential new development sites, to take care of the future recreation use problem on the Paradise Valley Ranger District up to the year 2,000. The survey covered the national forest lands within the entire sub-basin.

By the end of 1962 the Forest Service will have completed a Forest Recreation Management Plan for the entire Humboldt National Forest, including the Paradise Valley Ranger District. This plan will correlate recreation management with the other facets of multiple use. Based upon an anticipated expansion to 19 recreation areas, involving a total of 303 family camp and picnic units, the visitor days use by the year 2,000 would approximate 520 visitors per day for a 120 day season (four months). Peak loads of 1,500 visitors per day could be handled. Water requirements for this recreation use would average approximately 1,000 gallons per day which would be a total seasonal requirement of 120,000 gallons of water which must be planned for, or a total of approximately one-half acre-foot.

Table 19, compiled from the latest (1960) annual recreation statistical report for the Paradise Valley Ranger District, shows the recreation use, both camper and picnicker, for the ranger district as a whole for that year. The bulk of this recreation use is in the Humboldt Basin portion of the district; as there is no satisfactory method of breaking out the Quinn River portion, the use figures for the entire district, which includes Quinn River and the Little Humboldt Sub-Basin, are shown on the table.

Table 19. --Recreation use, Paradise Valley Ranger District, 1960

Recreation sites and areas	No. of visits	No. of man-days	Average lgth. of visit (days)
Developed campgrounds	350	525	$1\frac{1}{2}$
Developed picnic sites	500	500	1
Recreation residences	125	250	2
Other forest areas (sightseeing, hunting, hiking, riding, etc.)	7,956	5,867	-
Total	8,931	7,142	

Source: U. S. Forest Service

Because national forest and national land reserve lands are closely tied together in this sub-basin, the development of their recreation resource potential should be correlated. At the present time, there are no developed campground or recreation areas on the national land reserve lands. Table 20 show the sites the Bureau of Land Management proposes for development within this sub-basin.

Table 20. --Recreation inventory report, 1959, Bureau of Land Management picnic sites, Little Humboldt Sub-Basin

Name	Class	Potential No. of users	Acres	
			BLM	Other
1. Sand Dunes	Rest area	200 picknickers	40	-
	$500.00 total cost to BLM, $1,500.00 to to other groups (Service Clubs, etc.)			
2. The Orchard (Cottonwood Creek)	Picnic & camping access road construction needed	Not given	-	10
	$500.00 total cost to BLM, $1,500 to others			
3. Martin Creek	Fish pond, picnic facilities, access road construction & maintenance	Not given	10	10
	$500.00 total cost to BLM, $1,500 to others			

Source: Bureau of Land Management

The Little Humboldt Sub-Basin comprises approximately 18 percent of the land area and contains about a third of the land irrigated in Humboldt County. While historical data on land and water use, agricultural production, and organization and operation of ranches for the sub-basin are not available, statistical information for Humboldt County are indicative of trends within the sub-basin.

The relationship of sub-basin agriculture to Humboldt County agriculture has been modified during recent years. One major adjustment in land and water use is known to have begun to influence county statistics for the census year 1954, and is plainly evident in preliminary census data for 1959. Beginning about 1950 private individuals became very active in developing ground water supplies within the county by the installation of irrigation wells and the development of new land. This activity was centered in the Kings and Quinn River areas which are located within the county but outside the Little Humboldt Sub-Basin. Incorporation of statistics for this area in the 1959 census has modified the pattern of land and water use and agricultural production in Humboldt County. For example, from 1954 to 1959 the acreage of wheat harvested in the county increased from 200 to nearly 8,000 acres. It is believed that this increase occurred principally in the Kings and Quinn River ground water development areas.

Except for the recent increase in development of the ground water resources, the basic pattern of use of the land and water resources in the Little Humboldt Sub-Basin and in Humboldt County has not changed materially for many years.

Data for Humboldt County were used in developing estimates of the pattern of use of water and associated land resources in the Little Humboldt Sub-Basin, as shown in the following tables numbered 21 to 29 inclusive, and figures numbered 7 to 12 inclusive.

Table 21.--Value of land and buildings per ranch and per acre, State of Nevada and Humboldt County, 1910-60

Census year	Average value of land and buildings			
	Nevada		Humboldt County	
	Per ranch	Per acre	Per ranch	Per acre
	Dollars	Dollars	Dollars	Dollars
1910..........	14,730	14.58	18,816	8.80
1920..........	20,947	28.12	41,269	13.83
1930..........	18,626	15.71	19,702	9.80
1935..........	11,518	11.75	13,971	6.90
1940..........	13,321	12.57	12,304	6.61
1945..........	20,985	11.65	15,070	7.60
1950..........	36,078	22.70	55,412	10.96
1954..........	61,056	26.52	68,302	12.60
1960..........	107,840	37.99	145,447	20.69

Source: Compiled from U. S. Census of Agriculture data.

Table 22.--Value of farm products sold per ranch, Humboldt County, Nevada

Dollar value of farm products sold per ranch	Percentage distribution of commercial ranches			
	1944	1949	1954	1959
	Percent	Percent	Percent	Percent
25,000 or more....................	14.3	17.9	28.3	33.7
10,000 to 24,999..................	18.0	10.6	29.3	27.5
5,000 to 9,999....................	18.6	12.6	27.3	18.4
2,500 to 4,999....................	7.5	8.6	12.1	8.2
1,200 to 2,499....................	16.1	18.5	3.0	11.2
250 to 1,199......................	25.5	31.8	----	1.0
Total............................	100.0	100.0	100.0	100.0

Source: Compiled from U. S. Census of Agriculture data.

Table 23. --Type of ranches, Humboldt County, Nevada

Type of ranch	Percentage distribution of ranches			
	1944	1949	1954	1959
	Percent	Percent	Percent	Percent
Field crops.........................	3	3	4	7
Dairy...............................	4	0	0	0
Poultry.............................	1	0	0	0
Livestock other than dairy & poultry	78	63	84	70
General.............................	1	4	1	1
Miscellaneous and unclassified......	13	30	11	22
Total...............................	100	100	100	100

Source: Compiled from U. S. Census of Agriculture data.

Table 24. --Value of ranch products sold, Humboldt County, Nevada, 1939-1954

Item	Year 1939	1944	1949	1954
	Dollars	Dollars	Dollars	Dollars
All ranch products..............	852,933	1,754,212	2,898,026	2,354,612
All livestock and livestock products.......................	821,827	1,688,402	2,847,914	2,264,952
Livestock and livestock products other than dairy products	791,695	1,654,661	2,829,394	2,246,301
Dairy..........................	19,656	18,604	9,980	8,513
Poultry........................	10,476	15,137	8,540	10,138
All crops......................	31,106	65,810	50,112	89,660
Field crops other than vegetables, fruits and nuts.....	30,985	57,110	44,620	89,337
Vegetables, fruits and nuts....	121	8,700	5,492	323

Source: Compiled from U. S. Census and Statistical Reporting Service data.

Table 25. --Vaule of ranch products sold, in 1954 dollars, Humboldt County, Nevada, 1939-54

Item	Year 1939	1944	1949	1954
	Dollars	Dollars	Dollars	Dollars
All ranch products..............	2,251,065	2,660,896	2,733,473	2,354,612
All livestock and livestock products.......................	2,162,175	2,584,186	2,676,442	2,264,952
Livestock and livestock products other than dairy & poultry	2,097,992	2,548,178	2,659,630	2,246,301
Dairy..........................	45,012	21,022	9,980	8,513
Poultry........................	19,171	14,986	6,832	10,138
All crops......................	88,890	76,710	57,031	89,660
Field crops other than vegetables, fruits and nuts.......	88,617	68,532	51,759	89,337
Vegetables, fruits and nuts.....	273	8,178	5,272	323

Source: Compiled from U. S. Census and Statistical Reporting Service data.

Table 26. -Total ranch income and income per ranch, State of Nevada, selected years, 1930-59

Year	Source of income		Total ranch income	Realized income per ranch excluding inventory changes		Net income as a percentage of gross income
	Crops and livestock and livestock products	Other 1/		Gross	Net	
	1,000 dollars	1,000 dollars	1,000 dollars	Dollars	Dollars	Percent
1930	14,192	1,142	15,334			
1935	10,576	933	11,509			
1940	13,851	1,095	14,946			
1945	29,028	2,428	31,456			
1950	45,838	1,898	47,736	15,932	6,988	44
1951	62,591	2,339	64,930	20,727	9,853	48
1952	51,400	2,488	53,888	17,935	7,978	44
1953	41,824	2,188	44,012	14,006	4,341	31
1954	39,343	1,730	41,073	13,678	4,058	30
1955	37,514	1,449	38,963	13,416	3,279	24
1956	38,410	2,526	40,936	13,994	3,300	24
1957	50,006	2,832	52,838	16,719	5,597	33
1958	51,395	2,528	53,923	18,823	6,395	34
1959	53,098	3,010	56,108	20,289	6,820	34

1/ Includes income from government payments and value of products consumed on farm.

Source: Statistical Reporting Service

Table 27. -Land area and use, Humboldt County and Little Humbodlt Sub-Basin, 1959

Land use	Unit	Humboldt County	Estimated Little Humboldt Sub-Basin
Land area	Sq. miles	9,702	1,728.6
Land area	Acre	6,209,280	1,106,304
Land in farms.....................	do	1,014,833	252,784
Cropland	do	87,853	30,000
Cropland harvested.............	do	29,265	10,000
Cropland used only for pasture.	do	48,427	20,000
Cropland not harvested and not pastured........................	do	10,161	---------
Land pastured	do	971,894	222,784

Source: Compiled from U. S. Census of Agriculture data.

Table 28. --Land use, Humboldt County and State of Nevada, 1929-59

Year	Land in ranches	Cropland	Cropland harvested	Land pastured
	Acres	Acres	Acres	Acres
Humboldt County				
1929................	391,827	69,096	31,079	-------
1934................	439,691	31,573	18,480	-------
1939................	420,525	61,927	56,314	-------
1944................	438,236	64,811	64,811	358,843
1949................	842,946	69,657	43,507	787,914
1954................	878,024	86,874	24,641	841,301
1959................	1,014,833	87,853	29,265	971,894
Nevada				
1929................	4,080,906	572,418	397,504	-------
1934................	3,621,769	379,658	272,463	-------
1939................	3,785,106	451,688	435,855	-------
1944................	6,178,004	489,382	486,842	5,532,432
1949................	7,063,525	619,442	421,202	6,430,991
1954................	8,231,270	674,869	360,011	7,637,386
1959................	10,973,355	777,772	328,789	9,908,803

Source: Compiled from U. S. Census of Agriculture data.

Table 29. --Grazing use of Federal range, by months and by ranches headquartered in the Little Humboldt Sub-Basin, Nevada, 1960

Month	National forest		National land reserve		Total use	
	Horses	Cattle	Horses	Cattle	Horses	Cattle
	Animal units	Animal units	Animal units	Animal units	Animal units	Animal units
Jan........	------	------	26	979	26	979
Feb........	------	------	26	811	26	811
Mar........	------	------	43	2,700	43	2,700
Apr........	------	------	282	15,223	282	15,223
May........	------	651	304	19,182	304	19,833
June.......	18	7,015	304	11,388	322	18,403
July.......	27	10,476	315	8,972	342	19,448
Aug........	27	9,634	297	8,685	324	18,319
Sept.......	21	4,136	297	7,408	318	11,544
Oct........	------	------	288	1,328	288	1,328
Nov........	------	------	68	965	68	965
Dec........	------	------	25	945	25	945
Total....	93	31,912	2,275	78,586	2,368	110,498

Source: Compiled from U. S. Forest Service and U. S. Bureau of Land Management records.

Figure 7. - Number of Ranches and Tenure of Ranch Operators, Humboldt County, Nevada 1900 - 1960

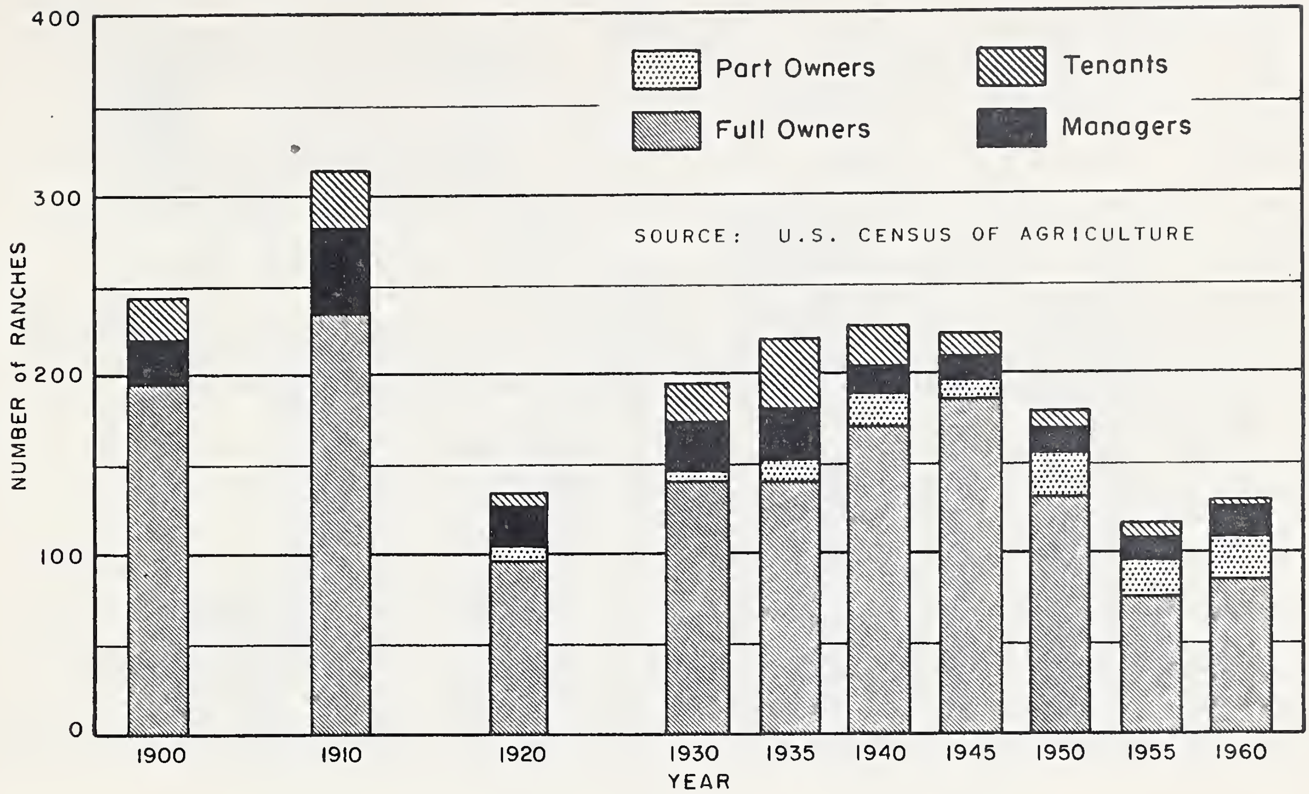


Figure 8. - Average Acres per Ranch, Humboldt County, Nevada, and State of Nevada 1910 - 1960

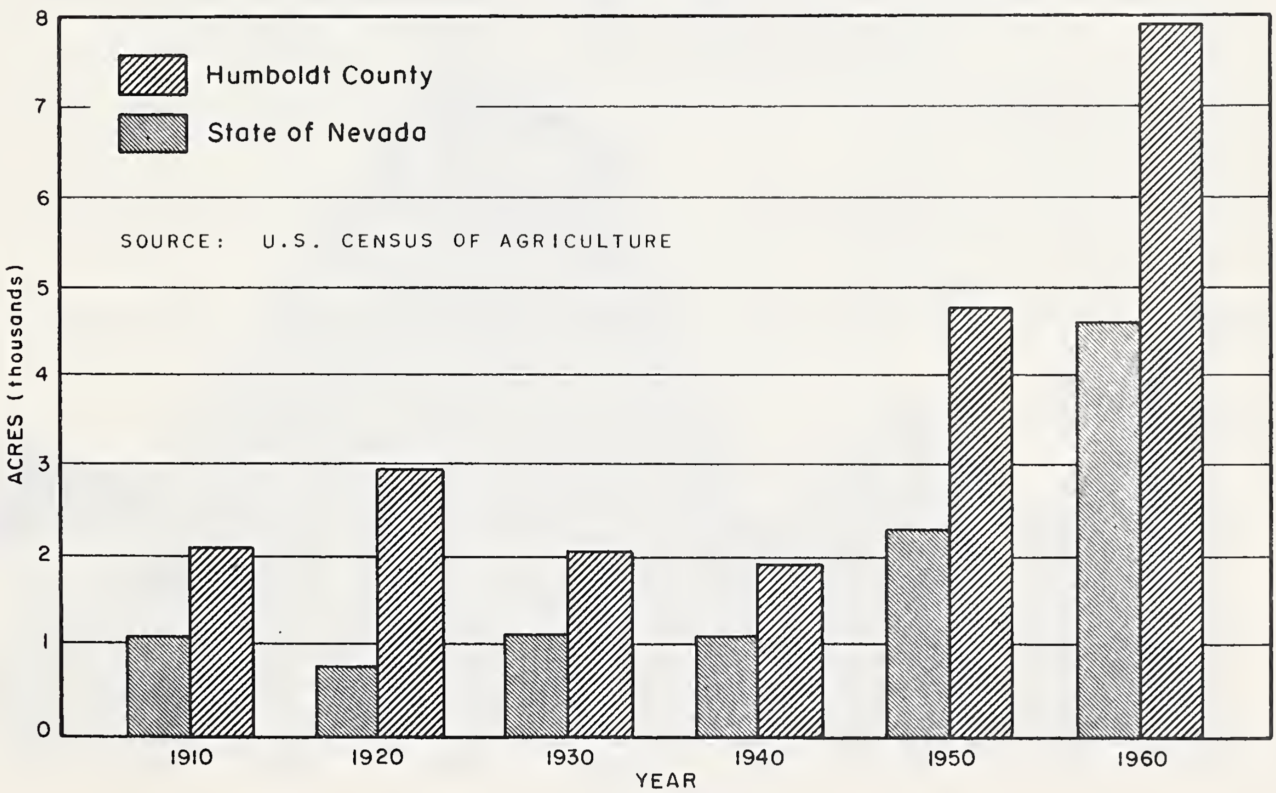


Figure 9. - Livestock Numbers, Humboldt County, Nevada, 1910 - 1960.

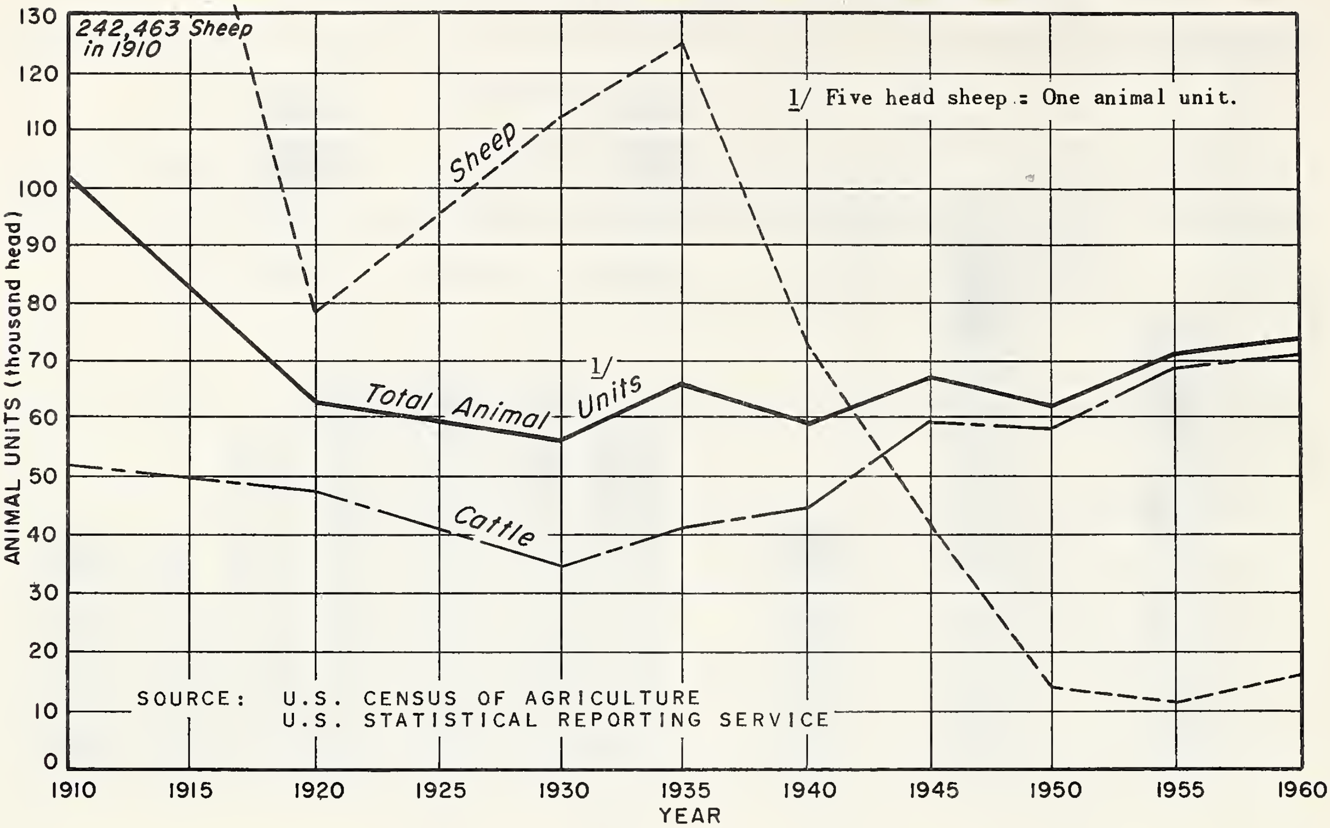


Figure 10. - Cropping Pattern, Humboldt County, Nevada, 1919 - 1959.

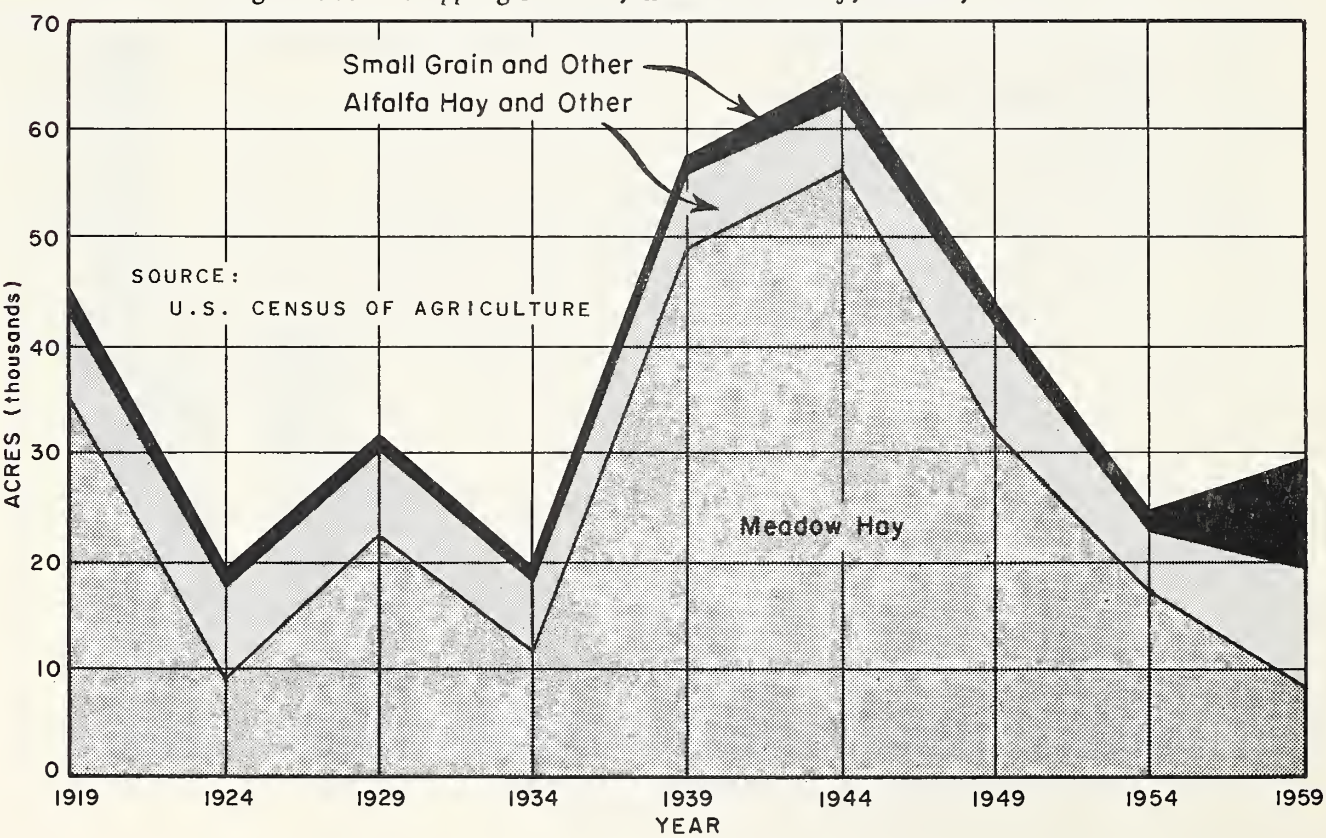


Figure 11. - Value of All Ranch Products Sold, Humboldt County, Nevada 1939 - 1954

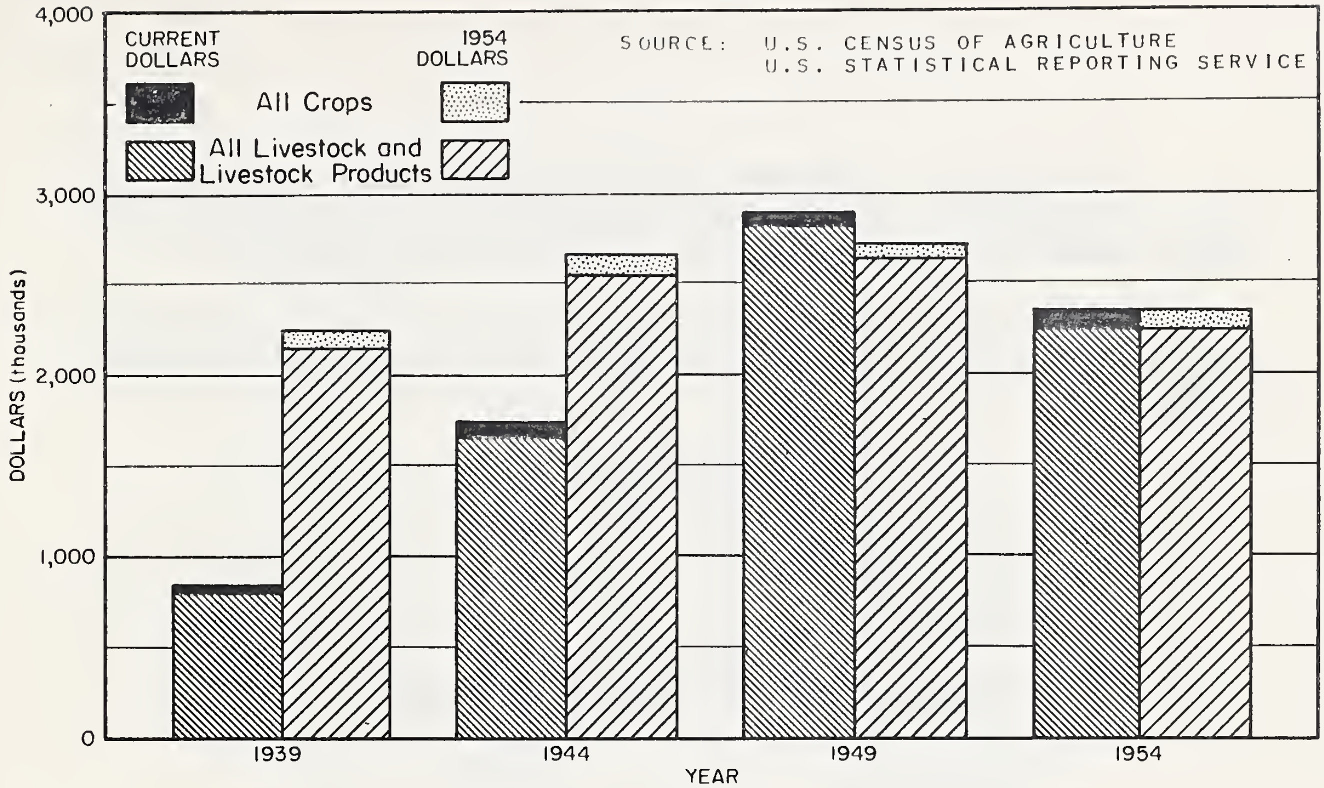
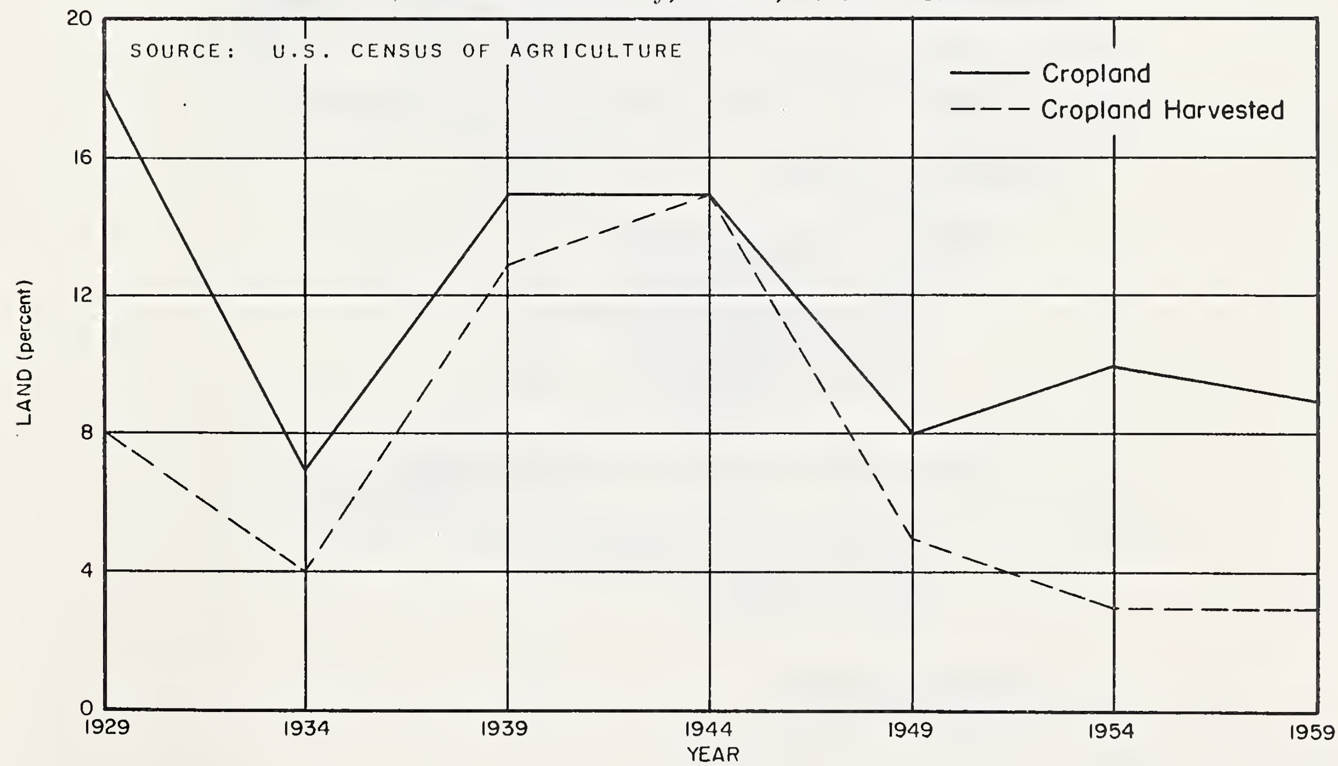


Figure 12. - Cropland and Cropland Harvested as a Percentage of Land in Ranches, Humboldt County, Nevada, 1929 - 1959.



APPENDIX II

This appendix is produced in a relatively limited number of copies. It contains material germane to the Little Humboldt Sub-Basin but which, because of its detailed or technical nature, is not attached to copies for general distribution.

Such material, however, has potential value as an information reservoir for technicians, administrators, and resource managers concerned with the Little Humboldt Sub-Basin.

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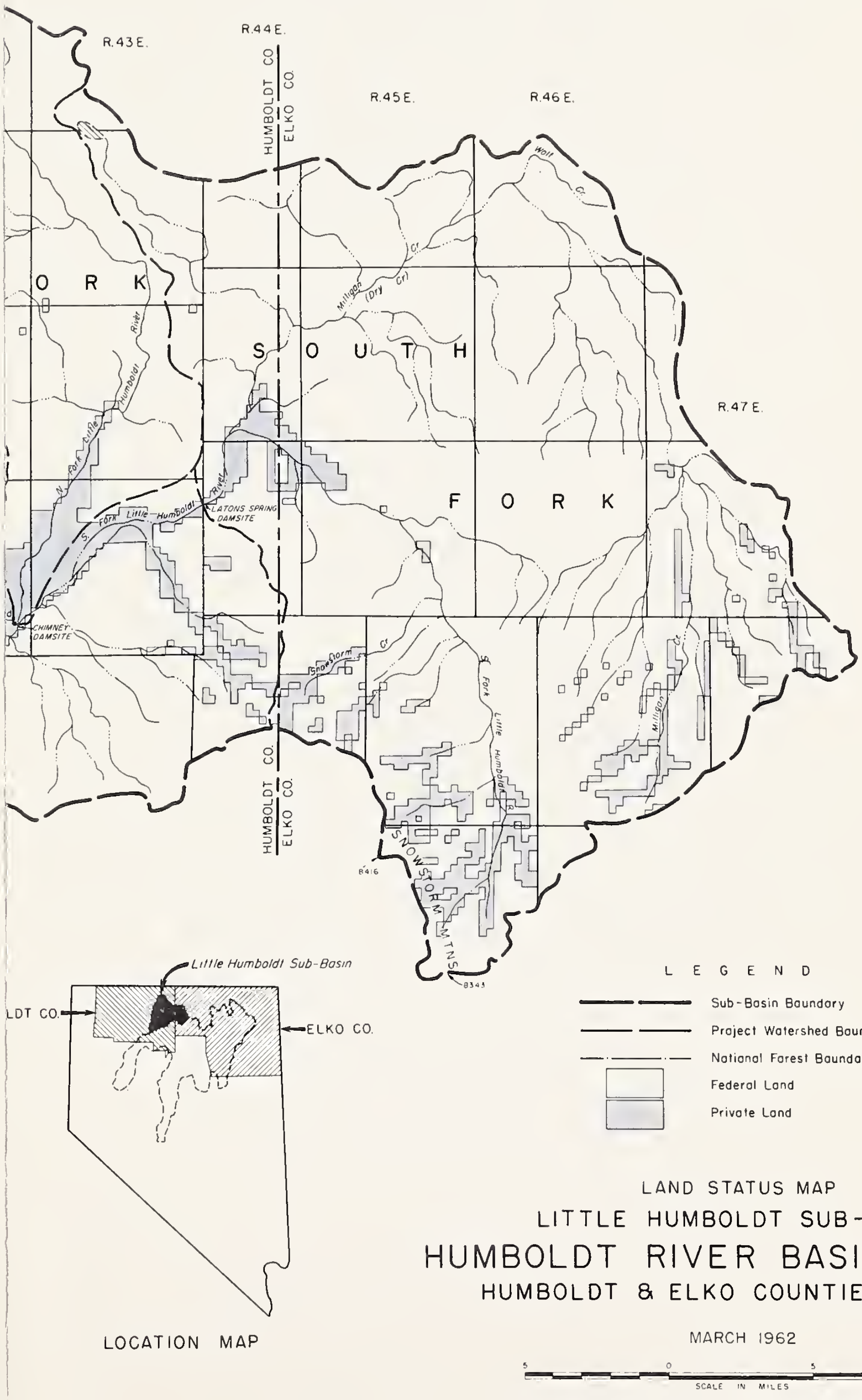


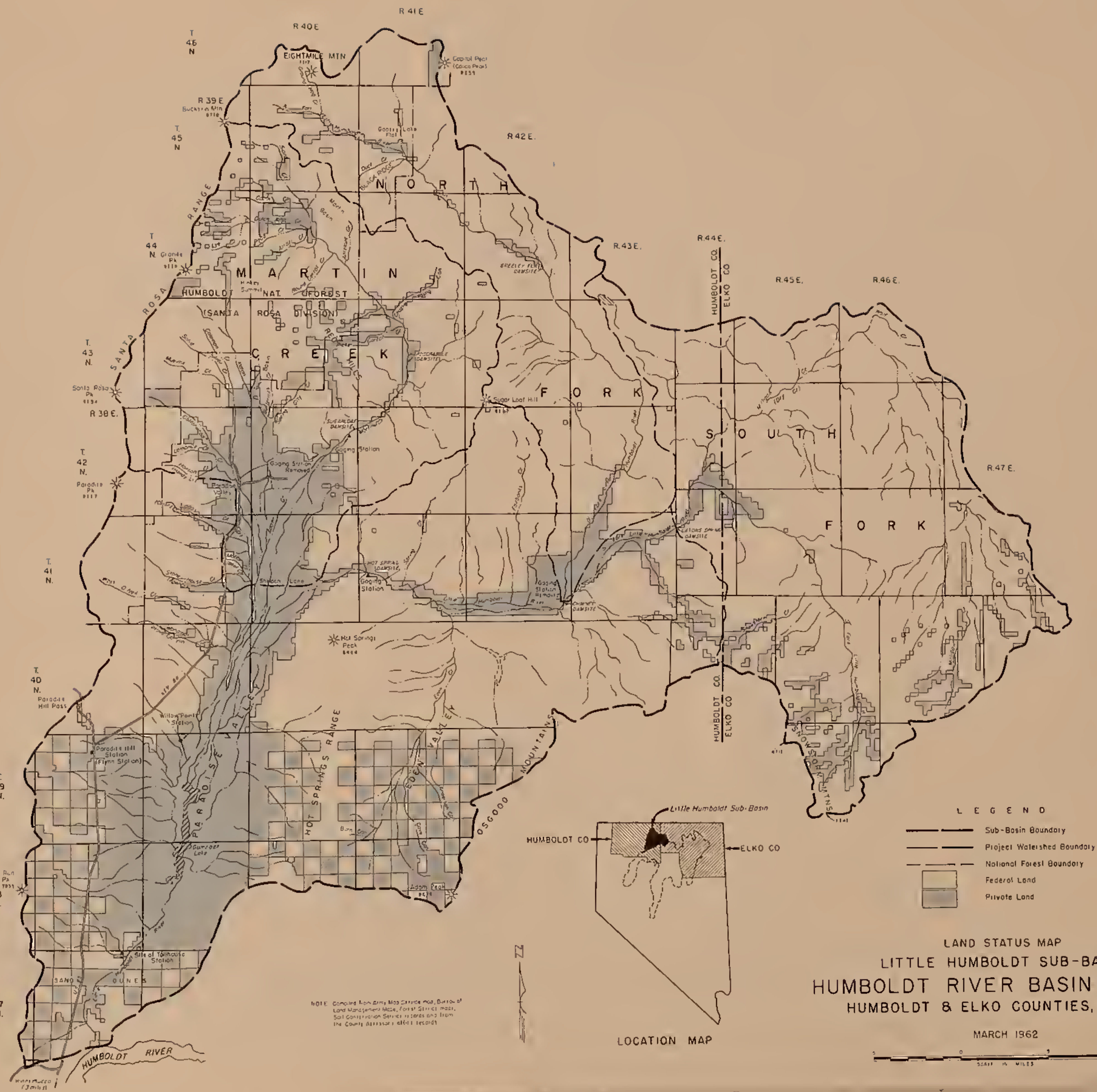
LAND STATUS MAP

LITTLE HUMBOLDT SUB-BASIN

HUMBOLDT RIVER BASIN SURVEY

HUMBOLDT & ELKO COUNTIES, NEVADA

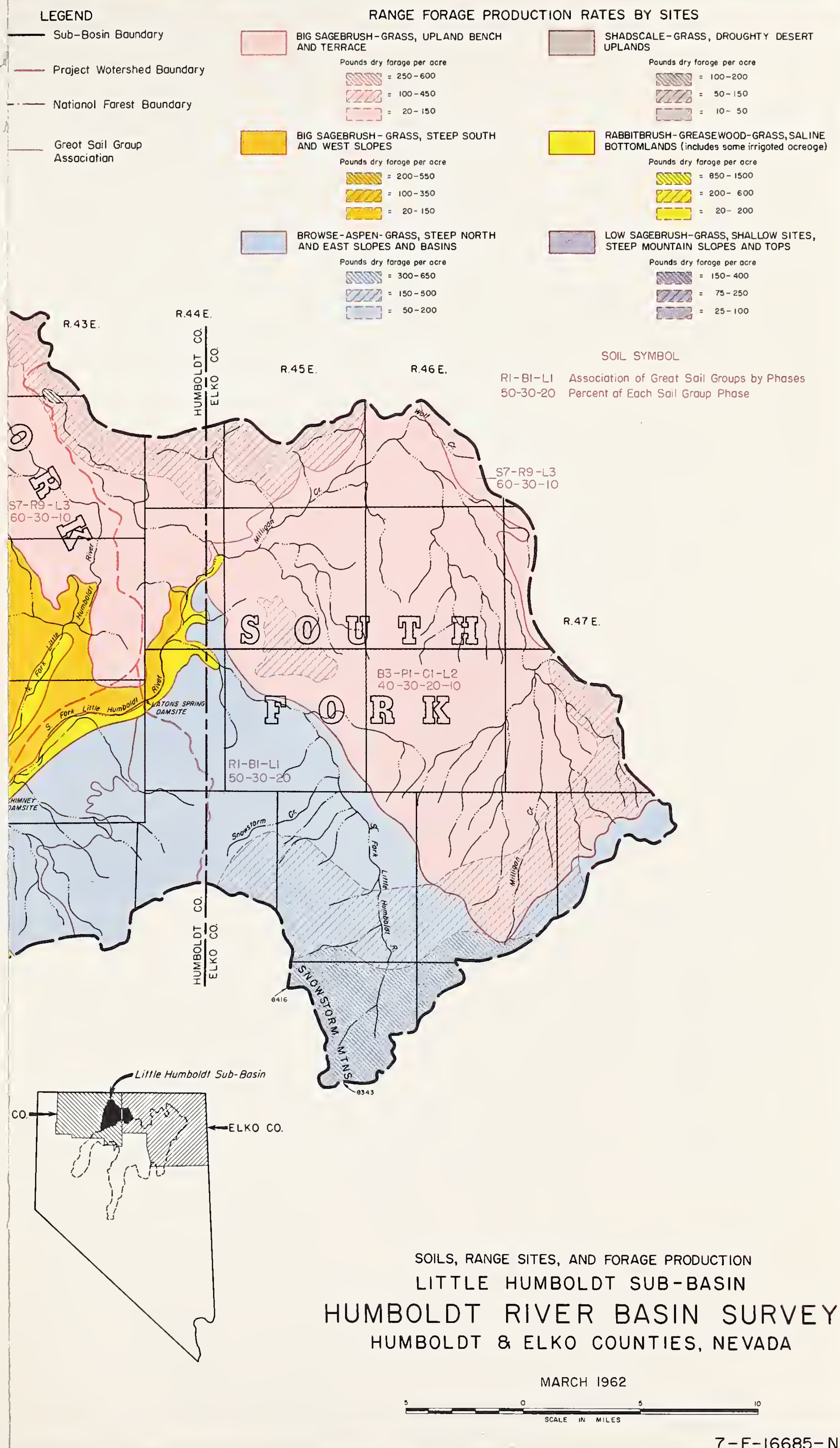
MARCH 1962

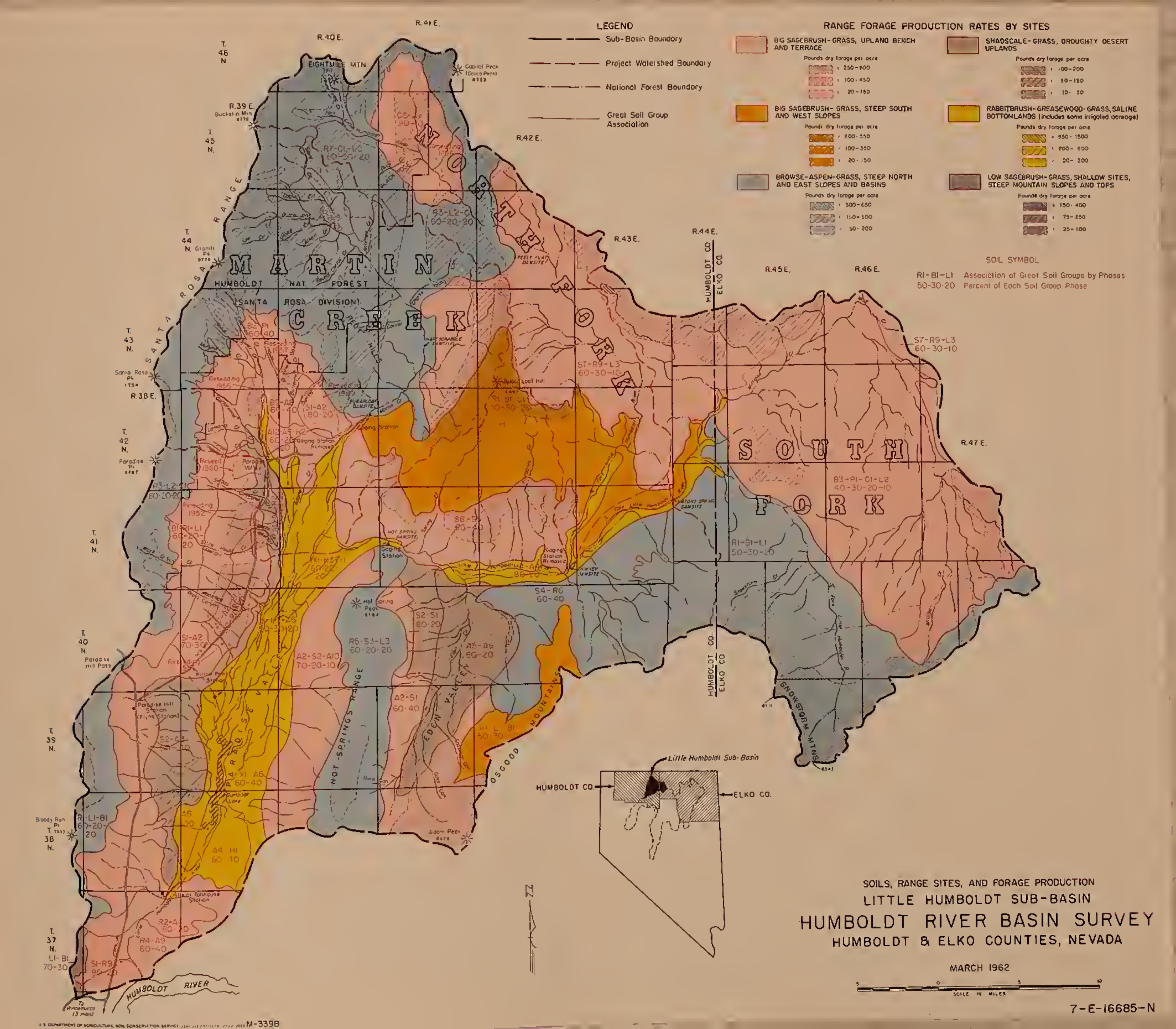


LAND STATUS MAP
LITTLE HUMBOLDT SUB-BASIN
HUMBOLDT RIVER BASIN SURVEY
HUMBOLDT & ELKO COUNTIES, NEVADA

MARCH 1962

7-E-16686-N


LEGEND
Sub-Basin Boundary
Project Watershed Boundary
National Forest Boundary
Great Soil Group Association
RANGE FORAGE PRODUCTION RATES BY SITES
BIG SAGEBRUSH-GRASS, UPLAND BENCH AND TERRACE
Pounds dry forage per acre
= 250-600
= 100-450
= 20-150
SHADSCALE-GRASS, DROUGHTY DESERT UPLANDS
Pounds dry forage per acre
= 100-200
= 50-150
= 10-50
BIG SAGEBRUSH-GRASS, STEEP SOUTH AND WEST SLOPES
Pounds dry forage per acre
= 200-550
= 100-350
= 20-150
RABBITBRUSH-GREASEWOOD-GRASS, SALINE BOTTOMLANDS (includes some irrigated acreage)
Pounds dry forage per acre
= 850-1500
= 200-600
= 20-200
BROWSE-ASPEN-GRASS, STEEP NORTH AND EAST SLOPES AND BASINS
Pounds dry forage per acre
= 300-650
= 150-500
= 50-200
LOW SAGEBRUSH-GRASS, SHALLOW SITES, STEEP MOUNTAIN SLOPES AND TOPS
Pounds dry forage per acre
= 150-400
= 75-250
= 25-100
SOIL SYMBOL
R1-B1-L1 Association of Great Soil Groups by Phases
50-30-20 Percent of Each Soil Group Phase
R.43E.
R.44E.
R.45E.
R.46E.
R.47E.
HUMBOLDT CO.
ELKO CO.
S7-R9-L3
60-30-10
S7-R9-L3
60-30-10
B3-P1-C1-L2
40-30-20-10
R1-B1-L1
50-30-20
SOUTH FORK
Wolf Cr.
Milligan Cr.
N. Fork Little Humboldt River
S. Fork Little Humboldt River
KATONS SPRING DAMSITE
CHIMNEY DAMSITE
Snowstorm Cr.
S. Fork Little Humboldt R.
Milligan
SNOWSTORM MTNS.
8416
8343
Little Humboldt Sub-Basin
CO.
ELKO CO.
SOILS, RANGE SITES, AND FORAGE PRODUCTION
LITTLE HUMBOLDT SUB-BASIN
HUMBOLDT RIVER BASIN SURVEY
HUMBOLDT & ELKO COUNTIES, NEVADA
MARCH 1962
5 0 5 10
SCALE IN MILES
7-E-16685-N


LEGEND
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RANGE FORAGE PRODUCTION RATES BY SITES
BIG SAGEBRUSH-GRASS, UPLAND BENCH AND TERRACE
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Pounds dry forage per acre
SOIL SYMBOL
R1-B1-L1 Association of Great Soil Groups by Phases
50-30-20 Percent of Each Soil Group Phase
MARTIN CREEK
NORTH FORK
SOUTH FORK
HUMBOLDT NAT. FOREST (SANTA ROSA DIVISION)
SANTA ROSA RANGE
HOT SPRINGS RANGE
PARADISE VALLEY
EDEN VALLEY
OSGOOD MOUNTAINS
SNOWSTORM MTNS
HUMBOLDT RIVER
HUMBOLDT CO.
ELKO CO.
Little Humboldt Sub-Basin
SOILS, RANGE SITES, AND FORAGE PRODUCTION
LITTLE HUMBOLDT SUB-BASIN
HUMBOLDT RIVER BASIN SURVEY
HUMBOLDT & ELKO COUNTIES, NEVADA
MARCH 1962
SCALE IN MILES
7-E-16685-N
M-3398

L E G E N D

———	Little Humboldt Sub-Basin Boundary
— — —	Land Use Boundaries
5000 ~	Elevation Contours in Feet

TYPE 1 GRASSLAND

Acr Agropyron cristatum (crested wheatgrass)
Eci Elymus cinereus (Great Basin wildrye)

TYPE 2 MEADOW

Dst Distichlis stricta (inland saltgrass)
Etr Elymus triticoides (creeping wildrye)
Soi Sporobolus airoides (alkali sacaton)

TYPE 4 SAGEBRUSH

Ari Artemisia tridentata (big sagebrush)
Cna Chrysothamnus nauseosus (rubber rabbitbrush)

TYPE 5 BROWSE-SHRUB

Sal Salix Spp. (willow)
Sar Shepherdia argentea (silver buffaloberry)

TYPE 14 GREASEWOOD

Sve Sarcobatus vermiculatus (black greasewood)

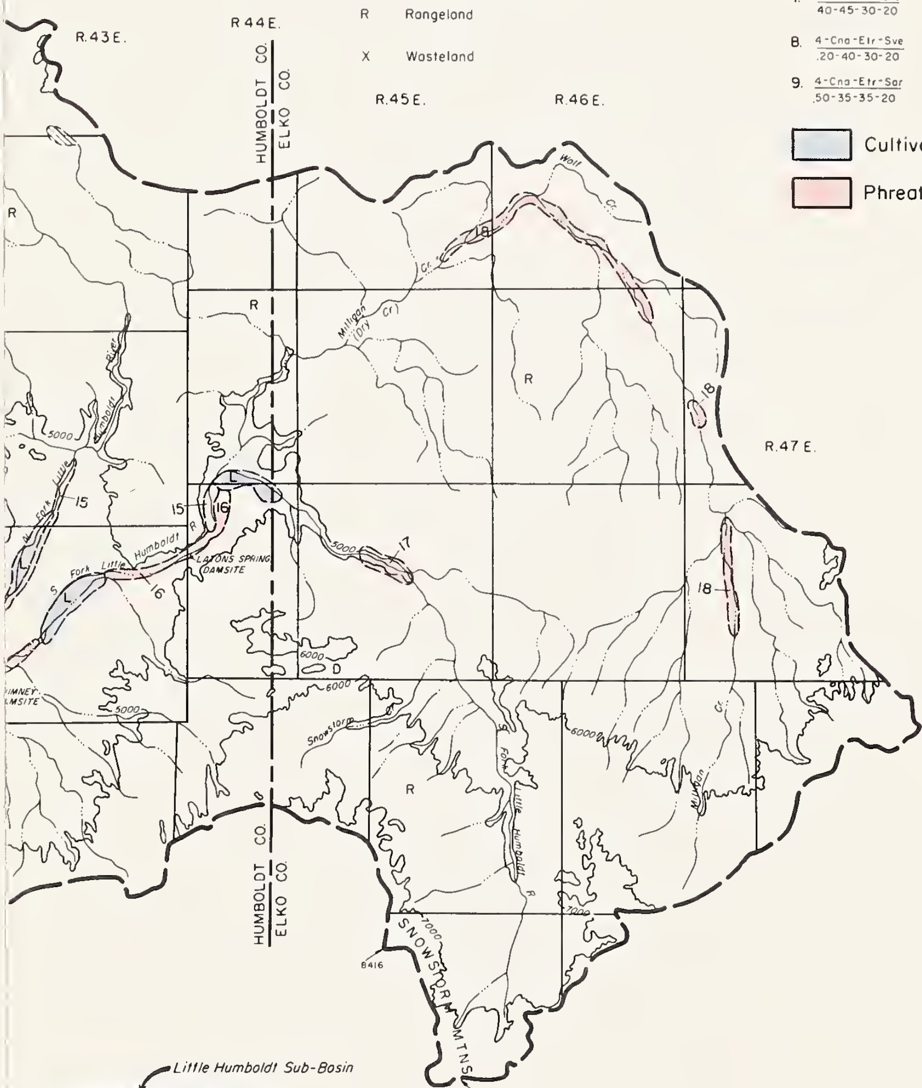
L Irrigated hay or pasture
R Rangeland
X Wasteland

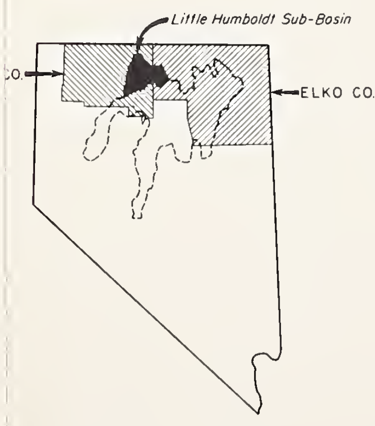
Type Number — Type Aspect — Abundant Species
5 - Sve - Ost - Eci
20 - 50 - 25 - 10
Average Total Areal Density — Percent of Species

1. 2-Ost / 20-90	10 4-Cna-Ari-Etr / .50-35-20-20-15
2. 14-Sve-Sal-Ost / 20-40-35-20	11. 5-Sal-Eci-Etr / .40-60-20-15
3 14-Sve-Sal-Etr-Eci / .20-55-20-10-10	12. 14-Sve-Cna-Eci-Etr / .20-50-20-10-10
4 5-Sal-Sal-Eci-Etr / 25-30-30-20-15	13 5-Sal-Cna-Eci-Etr / .25-55-20-10-10
5. 4-Cna-Etr-Sve-Sar / 20-30-35-20-10	14. 14-Sve-Cna-Eci-Etr / .25-60-15-10-10
6. 4-Cna-Etr-Sve / 40-50-30-15	15. 5-Sal-Cna / 25-70-20
7. 4-Cna-Etr-Sve / 40-45-30-20	16. 14-Sve-Cna / .25-70-20
8. 4-Cna-Etr-Sve / .20-40-30-20	17 4-Cna-Sve / .15-60-20
9. 4-Cna-Etr-Sar / .50-35-35-20	18. 4-Cna-Ari / 15-50-30

Cultivated Land

Phreatophytes





LOCATION MAP

LAND USE AND PHREATOPHYTE MAP

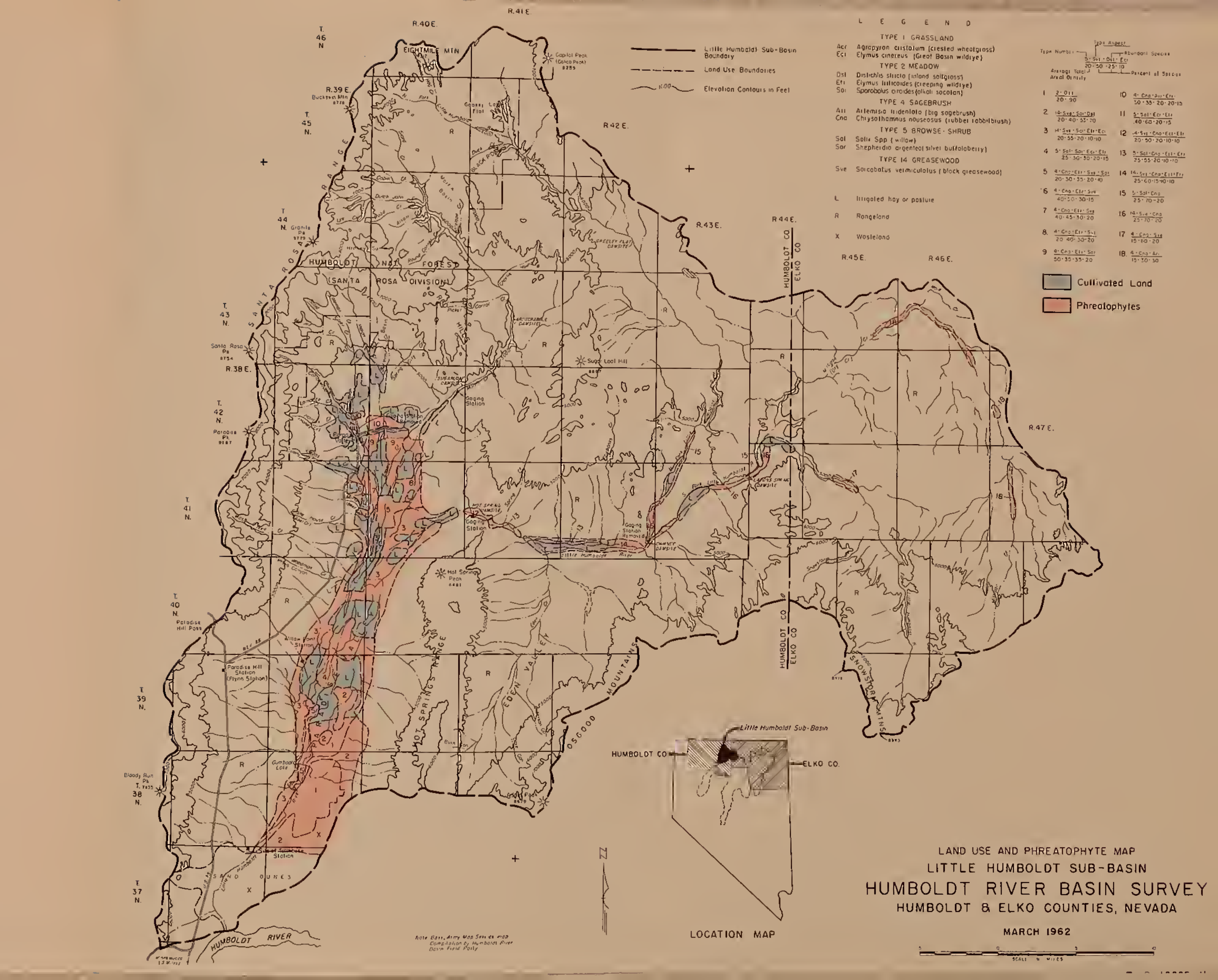
LITTLE HUMBOLDT SUB-BASIN

HUMBOLDT RIVER BASIN SURVEY

HUMBOLDT & ELKO COUNTIES, NEVADA

MARCH 1962

5 0 5 10


LEGEND
TYPE 1 GRASSLAND
Acr Agropyron cristatum (crested wheatgrass)
Eci Elymus cinereus (Great Basin wildrye)
TYPE 2 MEADOW
Dsl Distichlis stricta (inland saltgrass)
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TYPE 4 SAGEBRUSH
Atr Artemisia tridentata (big sagebrush)
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Sal Salix Spp (willow)
Sar Shepherdia argentea (silver buffaloberry)
TYPE 14 GREASEWOOD
Sve Sarcobatus vermiculatus (black greasewood)
L Irrigated hay or pasture
R Rangeland
X Wasteland
Little Humboldt Sub-Basin Boundary
Land Use Boundaries
Elevation Contours in Feet
Type Number
Type Aspect
Abundant Species
Average Total Areal Density
Percent of Species
Cultivated Land
Phreatophytes
HUMBOLDT NAT. FOREST (SANTA ROSA DIVISION)
SANTA ROSA RANGE
HOT SPRINGS RANGE
EDEN VALLEY
OSGOOD MOUNTAINS
SNOWSTORM MTNS.
EIGHTMILE MTN
HUMBOLDT RIVER
Little Humboldt River
SAND DUNES
HUMBOLDT CO.
ELKO CO.
Little Humboldt Sub-Basin
LOCATION MAP
LAND USE AND PHREATOPHYTE MAP
LITTLE HUMBOLDT SUB-BASIN
HUMBOLDT RIVER BASIN SURVEY
HUMBOLDT & ELKO COUNTIES, NEVADA
MARCH 1962